

FutureHorizons

The Global Semiconductor Industry Analysts



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Business Credentials

Providing

- **Industry & Market Research**
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- **R&D & Manufacturing**
- **Technology/Product Appraisal**
- **Due Diligence Reviews**
- **C-Suite Expert Analysis & Opinion**
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5 Decades Of Semiconductor Industry Experience

... From The First Commercial IC To SoC Integration

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Established in April 1989, **Future Horizons** provides industry analysis and consulting services to both public and private organizations on the global semiconductor and IT industries, from the underlying science and technology to the manufacture and applications. With more than 55 years of experience in the industry, dating back to the first commercial IC, to today's multi-billion transistor chips, our industry insights and expertise is widely considered to be the most accurate, insightful, and best in class. It is also widely recognised as a world authority on the Former USSR and East European electronics markets. Services include industry consulting, industry expert opinion, market research, training and business support for use in industry and due diligence analysis, investment, business planning and new market or product positioning and development. Its founder, Malcolm Penn, a 50+ year industry veteran, heads the company. Other key researchers include Russian-based analyst Sergey Orlov and CTO Mike Bryant, a highly experienced physicist, chip and systems designer.



RE: Final Draft Report (V06)

You forwarded this message on 12-Sep-17 2:15 PM.

Malcolm

Likewise – a pleasure to work with you on this and thanks for all your input and insight. To be honest it's a breath of fresh air to pay for commercial due diligence which actually provides valuable insight and commentary into the opportunity and which provides opinions and conclusions on the deliverability of the numbers.

Kind regards

Director

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RELEVANT EXPERIENCE (NON-EXHAUSTIVE)

Key Research Staff**Malcolm Penn, Chairman & Chief Executive Officer (Founder)**

Malcolm Penn is the Chairman and founder of Future Horizons, the global semiconductor industry analysts. He is also the President of Future Horizons' Moscow-based subsidiary firm, East-West Electronics, the world's top market research consultant on the Russian and East European electronics industry. Established in April 1989, Future Horizons provides business support services for use in opportunity analysis, business planning, and new market development in the semiconductor and related industries. Its areas of activity include market research reports, custom consulting, industry forums and seminars, IC and system design evaluation, and industry training.

Mr Penn has over 50 years' experience in the electronics industry and, for most of that time, has worked extensively throughout Europe as well as in the United States, the former USSR, Japan and Korea. Future Horizons was also a member of the 1994 European Commission sponsored Cornu Panel of senior industry executives responsible for publishing the "Report of the European Microelectronics Panel" used to help formulate the strategy for EC microelectronics support in Europe and the formation of MEDEA.

His industrial experience has involved him with all aspects of the management, manufacturing, marketing and use of electronic components, particularly semiconductor devices. His previous responsibilities included the management of semiconductor operations, export sales, sales forecasting, budgeting, market intelligence and data gathering, competitive analysis, new product planning, promotion and marketing of semiconductor components, and the design and development of digital electronic instrumentation.

Prior to establishing Future Horizons, Malcolm was Vice President of Dataquest and Director of Dataquest's European Operations, responsible for establishing all Dataquest's European-based research operations. Before joining Dataquest, he was Manager of Component Engineering for ITT Europe (now Alcatel), and prior to that, held various operations and marketing management positions with the worldwide ITT Semiconductor group.

Mike Bryant – Chief Technology Officer

Mike Bryant is Future Horizons' Chief Technology Officer. He is an experienced rf and analogue/mixed signal IC design engineer, specialist in providing IC design and consultancy services on hardware and systems design partitioning, software and digital signal processing design methodology and implementation. He has extensive experience in the use of power discrete devices in highly integrated OEM system designs.

Upon graduation in 1977, Mr Bryant joined Hewlett Packard's Queensferry Telecommunications Division in Scotland. He worked there for ten years on a variety of audio and PCM (Pulse Code Modulation) telecommunication test equipment, and also on large-scale system performance monitoring software. Successful projects at Hewlett Packard included the HP3779 PCM Terminal Analyser, the HP3776 PCM Terminal Test Set, and the HP4947 Transmission Impairments Measuring Set.

He joined Fujitsu Microelectronics in January 1988 and managed the growth of the Communications VLSI R&D laboratory based in Manchester, England. Recognising the convergence of many software and digital hardware design techniques, this was one of the first places in Europe to use HDLs (Hardware Definition Languages) and logic synthesis exclusively for all logic design. This permitted many software design methodologies to be used to improve design efficiency, and also gave better design flexibility in the design of ICs using both specialised hardware and on-chip firmware to meet design requirements. Projects here included both analogue and digital VLSI ICs for various ISDN terminals, voice data compression equipment, X.25 and frame relay controllers and telecommunications system switching control equipment.

Mike then joined Westell Europe as head of Systems Engineering, based in Cambridge, England. Westell was the first company to develop ADSL and HDSL modems for the provision of high-speed data access using existing telephone lines. Working in conjunction with the Copper Access group at BT, the Westell Supervision Broadband Access Platform was specified under Mike's supervision, and designed in Europe to meet their requirements. This is based upon a high-performance ATM switching core, a variety of ATM network interface cards, controlled by a SNMP based management system. This type of product has since become known as a DSLAM (Digital Subscriber Line Access Multiplexor). Similar products exist for other access technologies such as wireless, optical or cable.

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In addition to Mike's extensive experience in the communications-related industries, other experience includes Soundcraft Electronics (part of the Harman Audio group of companies), one of the world's leading manufacturers of professional audio mixing equipment for live, broadcast and recording use, to head their R&D development team of 35 people. The consoles used advanced digital technology, including high speed 24 bit A-D and D-A converters to transfer analogue signals to and from the analogue domain, all other signal processing being undertaken by banks of the high-performance DSP chips. A selection of Ethernet, ATM, USB, Firewire, Bluetooth, ADAT and TDIF interfaces allowed internal and external networking to other equipment.

Sergey Orlov - Executive Director, East-West Electronics

Based in Moscow, Russia, Sergey Orlov is Executive Director of East-West Electronics, a wholly-owned subsidiary of Future Horizons; a position he has held since the establishment of East-West Electronics in August 1991. Prior to joining the Future Horizons organisation full time, Mr Orlov was project manager for AmSovInvest, a Russian/American joint venture specialising in new business opportunities between Russian and western firms, in the position of Future Horizons account manager. AmSovInvest represented a change of career direction, from medicine, where he was a fully qualified doctor, to electronics, driven by his personal interest and hobby in computers and software and the new opportunities opened up by perestroika. Mr Orlov is fluent in Russian and English.

Multi-Client Reports

Future Horizons publishes a range of multi-client, market research reports, covering various aspects of the European and worldwide semiconductor and electronics industry. Due to the fast-changing nature of the information published, reports are researched and updated on an annual basis. Key current reports include:

- FH Monday (Weekly)
- Monthly Newsletter (Monthly)
- Semiconductor Monthly Report (12 issues p/a)

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RELEVANT EXPERIENCE (NON-EXHAUSTIVE)

Consulting Projects

Future Horizons is very experienced in working with governments, both at the EU Executive and DG levels, and country Public Authorities (PAs), particularly in the area of SC manufacturing and the role of semiconductor R&D research in Europe. Much of this work has been on a strictly confidential basis and cannot be disclosed or even listed below as a 'Client Confidential' entry. Examples that are in the public domain range from our early work on the post-JESSI EU MEDEA initiative to the EU Commission sponsored SMART Report on 450mm, which in turn led to the EU Horizon 2020 '10/100/20' so-called 'Airbus of Chips' initiative.

The majority of our other semiconductor industry consulting projects, whether for public and private financial organisations, including the European Investment Bank (EIB), private institutional banks, VC and PE firms, or for a wide range of international electronics, semiconductor industry, IT and communications firms, are also under strict NDA restrictions but examples that are now in the public domain include our work as an Expert Advisor and Market Analyst for SK-Telecom and Macquarie Securities' successful bid to acquire Hynix Semiconductors and the due diligence work we undertook for the successful spin-out of Newport Wafer Fab from Infineon Technologies.

A non-exhaustive sampling of our consulting experience, not subject to NDA include, but not limited to, in reverse chronological order, the projects listed below.

UK Semiconductor Ecosystem. An analysis of the UK semiconductor ecosystem and value chain, from design through manufacturing. (Client Confidential - Jan 2021)

Malaysian Semiconductors. An analysis of SilTerra's market position and capability. (Client Confidential - Nov-Dec 2020)

India Semiconductor Industry. An analysis of the indigenous manufacturers in the Indian semiconductor industry. (Toppan - Aug 2020)

Semiconductor Industry Value Chain. A market analysis of the global semiconductor industry value chain, from design through end applications and services. (ATREG - Jan 2020)

Compound Semiconductor Market Update: A market analysis of the compound semiconductor market. (CWJ - Sep 2019)

DRAM Market Analysis. DRAM market supply and demand market analysis, expert witness report and trial testimony (Foran Glennon - Mar 2018-May 2019)

DRAM Market Cartel Analysis. Impact of the 2012-13 US DRAM market cartel on the European DRAM competitive market position. (Granville - Jul 2018-Dec 2018)

50 Years of Semiconductors. A review of the business and social impact of semiconductor industry. (Client Confidential – Sep 2018)

technology VCSEL Market Opportunity: A market opportunity analysis of the VCSEL device market. (Client Confidential - Jan-Feb 2018)

UK Wafer Foundry Opportunity: A commercial due diligence analysis on the viability of setting up a new UK-based power IC wafer foundry. (Welsh Government/HSBC – Aug-Sep 2017)

Vacuum Deposition Industry: An analysis of the vacuum deposition market, technology and competitive positioning. (Elliot Advisors - May 2017)

Novel Thin-Film Transistor Processing: A due diligence analysis of a novel new sputtering technique for thin-file transistor production (Manchester University - Apr-May 2017)

Semiconductor M&A Appraisal. A strategic analysis of the rationale driving the renewed SC industry global M&A activity (European Commission - Jan-Apr 2016)

Competitive Analysis Review. A market positioning and SWOT analysis of STMicroelectronics & Infineon Technology (Client Confidential - Oct-Nov 2015)

MEMS & Sensor Market Analysis Review. A market positioning and SWOT analysis of the key global suppliers (Client Confidential - Aug-Sep 2015)

Business Credentials

RELEVANT EXPERIENCE (NON-EXHAUSTIVE)

450mm Wafer Fab Investment Cost Analysis. An analysis of the economics and recommendation for novel funding mechanisms to support setting up a prospective advanced 300mm / 450mm wafer fab in Europe (Client Confidential - Mar-Sep 2015)

Catrene. An analysis and status review of the EU Catrene initiative. (Client Confidential - Mar 2015)

ECSEL. An analysis and status review of the European ECSEL initiative. (Client Confidential - Mar 2015)

Industrie 4.0. An analysis and status review of the German Industrie 4.0 initiative. (Client Confidential - Feb 2015)

WW Memory Market Report. An analysis of the strategic M&A NAND Flash market opportunities. (Macquarie Securities - Jun-Aug 2014)

Bridge 450mm. Further business and Market support for the European 450mm implementation and roll-out initiative (European Commission – Jan 2014-Dec 2014)

Enable 450mm. Business and Market development support for the European 450mm implementation and roll-out initiative (European Commission – Feb 2013-Dec 2013)

WW Memory Market Report. An analysis of the strategic M&A opportunities for SK-Hynix. (Macquarie Securities - Sep-Nov 2013)

GSS Implementation Due Diligence Report. An independent expert assessment of the GSS Business Plan (Scottish Enterprise - Apr-May 2012)

GSS Due Diligence Report. A market analysis and business opportunity review on the proprietary transistor variability performance IP developed by GSS at Glasgow University (Scottish Enterprise - Feb 2012)

450mm Wafer Transition Report. A global analysis of the benefits and measures to set up 450 mm Semiconductor Prototyping and to keep semiconductor manufacturing in Europe. The role of public authorities and programmes. (European Commission - Jan 2011-Feb 2012)

Competitive Position Analysis. A market positioning and SWOT analysis of the three European major SC suppliers (Client Confidential - Oct-Nov 2011)

Russian Smart Foundry Opportunity. A due diligence analysis and advice on setting up a smart wafer foundry in Russia. (Angstrom-T - May-Aug 2011)

European R&D Initiatives. An overview of CATRENE R&D initiatives nanoelectronics. (Client Confidential - Nov 2010)

WW Memory Market Strategic Opportunity Report. An analysis of the global memory market and independent expert advice on the strategic positioning and M&A opportunities for SK Telecom's prospective acquisition of Hynix. (Macquarie Securities - May-Dec 2010)

Long-Term Market Prospects For The Fab-Lite Business Model. An analysis of the potential competitive advantages and disadvantages of adopting a fab-lite IDM business strategy. (Client Confidential - Aug-Oct 2009)

Anti-Competitive Analysis of the Proposed NEC-Renesas Merger. A commercial, market and technical appraisal of the potential anti-competitive aspects of the proposed Renesas-NEC merger. (Client Confidential - Jul-Sep 2009)

EDA Deep Sub-Micron Statistical Modelling Tools. A due diligence report on the market opportunity for a proposed start-up venture to be spun out from a UK University. The Report focuses on the key commercial assumptions for the business in terms of product, price and available market potential with a view to assessing the start-up business model viability. (Scottish Enterprise - Mar 2009)

Silicon Oscillators. A top-level domestic and export business opportunity and technology analysis for a novel new technology for silicon oscillators/resonators. (eoSilicon - Jan 2009)

Embedded Die. A technology and business opportunity report for a novel new packaging technology for embedding die and other components inside a PCB. (Imbera Electronics - Jun 2008)

RF IC Testing. A technology and business opportunity analysis for a novel new technique for testing rf ICs in the mobile wireless and networking markets. (ATTEDA - Mar 2008)

Machine Vision LED Lighting Controller. A market opportunity analysis for a novel range machine vision LED lighting controllers in the semiconductor and associated equipment industries. (Gardasoft - Sep 2007)

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Freescale Semiconductor. A company analysis of its product and market share positioning together with a SWOT analysis and restructuring recommendation. (Permira - Apr 2007)

High Volume European 200mm Wafer Foundry. A business and market opportunity study for a proposed new European-based 200mm semiconductor wafer foundry. (Client Confidential - Apr 2007)

European R&D Report. A description of the various European and individual country R&D initiatives in the field of microelectronics (including MEMS) and nanotechnology together with a review of their current status, objectives and progress. (SIRIJ - Mar 2007)

European R&D Initiatives. An overview of the various European and country R&D initiatives in the field of microelectronics and nanotechnology. (Client Confidential - Mar 2007)

Freescale Semiconductor. A company analysis of its products, markets, technology and applications. (Permira - Oct 2006)

Flash Memory. An overview of the worldwide Flash memory market (Permira - Oct 2006)

East European Scenario Analysis. An overview an opportunity analysis on design innovation and opportunities in the East European microelectronics industry. (Cadence - Jun 2006)

Philips Semiconductor. A company analysis of its products, markets, technology and applications. (Permira - May 2006)

Automotive Semiconductor Industry Trends. A market opportunity analysis of the key automotive semiconductor industry issues and trends. (Fujitsu Microelectronics - May 2006)

EDA Industry Trends. A market opportunity analysis of the key semiconductor industry issues and trends, and their likely impact on the EDA market. (Mentor Graphics - Jan 2006)

Semiconductor Application Markets. A market study of the key semiconductor application markets and the likely investment opportunities for the semiconductor VC industry. (Client Confidential - Oct 2005)

Advanced Concepts For SoC. A business and market opportunity study for a proposed new fables semiconductor start-up. (Client Confidential - Aug 2005)

Market Analysis For Thinned Semiconductor Wafers. A market opportunity analysis and key industry trends for thinned semiconductor wafers. (Asyntis - Jun 2005)

Analogue IC Test Methodology Technology Audit & Market Opportunity Analysis. A technology audit and market analysis of the potential business and customer opportunities in the analogue and mixed-signal microelectronics systems and SoC IC test market. (Client Confidential - Feb 2005)

Semiconductor Wafer Fab Investment Trend Analysis. A bespoke study on the size, technology, and investment trends in the semiconductor wafer fab market. (European Investment Bank - Nov 2004)

European Semiconductor Investment Opportunity. A strategic analysis and critique of the investment criteria and feasibility for a European-based 300mm advanced semiconductor wafer foundry. (Scottish Enterprise - Oct 2004)

FPGA & SoC IC Design Methodology Technology Audit. A technology and market potential audit for a novel methodology for SOC/FPGA IC design. (Client Confidential - Aug 2004)

SoC IP Market Analysis. An end market size and semiconductor content analysis of the digital consumer electronics market pertinent to a novel IP technology development. (Client Confidential - Apr 2004)

Power MOSFET/BCD Market Analysis. A market and technology analysis of the discrete power MOSFET and integrated BCD markets together with a recommended potential business entry strategy. (Client Confidential - Apr 2004)

Semiconductor Wafer Market Analysis. A bespoke study on the size, technology, and investment trends in the silicon wafer market. (Wacker Siltronic - Sep 2003)

Nanometer IC Technology Development. An analysis of the technological and industrial aspects of next generation nanometric microchip development. (European Commission - May 2003)

East European DRAM Market Analysis. A study on the market size and technology trends in the East European DRAM market (Infineon Technologies - May 2003)

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RELEVANT EXPERIENCE (NON-EXHAUSTIVE)

Analogue & RF Electronics Market Analysis. A market research report and analysis on the technology and design aspects and likely future trends associated with analogue and RF electronics (Scottish Enterprise - Aug 2002)

DRAM Industry Structure. A strategic analysis of the DRAM industry and its relative importance to the global semiconductor industry. (European Commission - Jan 2002)

SiGe Foundry Opportunity. A strategic analysis of the SiGe wafer foundry potential and the relative pricing levels compared with bulk CMOS wafer technology. (European Investment Bank - Oct 2001)

Electronic Design Business Development: A bespoke market research and analysis programme for the preparation of two reports related to the developments in business technology for electronic design. (The Alba Centre - Sep 2001)

Semiconductor IC Design & Wafer Fab Support. A bespoke market research support programme for the provision of technical and market information on the semiconductor IC design and wafer fab industries. (Scottish Enterprise - May 2001)

European Semiconductor Investment Opportunity. A strategic analysis and critique of the Atmel foreign direct investment proposal for the mothballed Siemens' NTS wafer fab, including presentation to the DTI review board. (UK Department of Trade & Industry - Sep 2000)

European Semiconductor Investment Opportunity. A strategic analysis and critique of the Amkor foreign direct investment proposal for the mothballed Siemens' NTS wafer fab. (UK Department of Trade & Industry - May 2000)

European Semiconductor Investment Opportunity. A strategic analysis and investor (Mosel Vitalic) of the investment opportunity for the three wafer fab plants currently lying vacant in the UK. (UK Department of Trade & Industry - Nov 1999)

MEDEA Mid-Term Assessment. An Executive Report to bench-mark the current status of MEDEA relative to its own objectives and current industry practice. (MEDEA Activities Co-ordination - MAC - Members - Dec 1998 to May 1999)

IC Wafer Fab Facility Investment Risk Assessment. An analysis of the factors affecting and influencing foreign direct investment in wafer fab. (Consultus, on behalf of Sandvikem, Sweden- Oct 1997)

Semiconductor Wafer Fab Production In Europe. An analysis of the European semiconductor manufacturing industry and potential investment opportunities for inwards investment. (NUTEK, Sweden - Mar 1997)

SC Wafer Fab Requirements In Europe. An executive study on the market and economic factors affecting semiconductor wafer fab investment in western Europe. (European Investment Bank - Aug 1996 to Sep 1996)

European Semiconductor Growth Analysis. An analysis of the UK and European competitive situation in the world-wide and European semiconductor manufacturing industry. (UK Department of Trade & Industry - first published Apr 1996, updated yearly)

The MEDEA Proposal. An executive study on the suitability of MEDEA as an appropriate follow-on step for a new pan-European microelectronics initiative. (Dutch Ministry of Industry & Economics - Mar 1996 to Apr 1996)

The Effect Of Silicon Foundries On Economic Development. An analysis of the European market potential for an independent UK/European-based silicon foundry and its likely impact on the UK economic development. This study was used by the Welsh Development Agency to justify the UK Government's \$100 million public support for the setting up of Newport Waferfab Ltd & LG Semicon wafer fabrication sites. (Welsh Development Agency - Dec 1994 to Apr 1995)

European Microelectronics Panel. Future Horizons was part of an EC-commissioned panel of senior industry executives, led by Mr J Cornu, Technical Director Alcatel nv, charged with publishing a report on European Microelectronics to be used to help formulate a strategy for future EC R&D funding. (EC - May 1994 to Jan 1995)

Russian Microelectronics Manufacturing. A strategic overview of the opportunities and benefits of developing an advanced IC manufacturing capability within Russia, with particular emphasis on the downstream significance to the Russian electronics systems manufacturing industry. (Russian Ministry of Electronics - May 1994 to Nov 1994)

Power Discrete Semiconductor Market Analysis. A strategic review of the high-power bipolar and MOS discrete semiconductor market with the view to develop a business plan for a new firm planning to enter the market (Client

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confidential - Apr 1994)

Business Development Plan. A study on the feasibility, cost, operation, market and associated business development plan to set up an advanced wafer fabrication facility in Russia. (Angstrom/CS First Boston/EBRD - Jan 1994 to Nov 1994)

European Silicon Wafer Manufacturing Opportunity. A study on the market opportunity and feasibility of setting up an advanced 150mm silicon wafer production facility in Europe, targeted at the European IC manufacturing industry, including an analysis of the current and projected market need and potential downstream benefits (i.e. incremental sales potential) for a world-wide silicon market leader but with currently no EU-based wafer manufacturing capability. (Client Confidential - Sep 1994 to Oct 1994)

Strategies For Developing The Microelectronics Industry In China. A study on the feasibility, cost, and operating plan to set up an advanced wafer fabrication facility in China. (Client Confidential - May 1993 to Oct 1993)

European IC Back-End Manufacturing Trends. A study of the market opportunity and feasibility of setting up an independent back end semiconductor capability in Europe targeted at the high pin count, high complexity market. (Client Confidential - Dec 1991 to May 1992)

European IC Wafer Fab Opportunity. A study on the market opportunity and feasibility of setting up an advanced (proprietary) IC wafer production facility in Europe, targeted at the European IC end user market, including an analysis of the current and projected market need and potential downstream benefits (i.e. incremental sales potential) for a niche player but with currently no EU-based wafer manufacturing capability. (Harris Semiconductor - Sep 1989 to Dec 1989)

UK Semiconductor Support Industry Evaluation. A study to describe the critical elements for the manufacture of advanced semiconductor devices including the site, cost and infrastructure issues together with the relevant upstream and downstream implications. (Welsh Development Agency - Apr 1989 to May 1989).

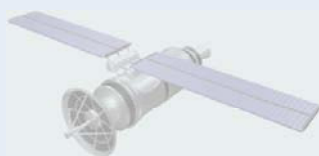


**31 Years Of Service
Founded April 1989**

**6th Decade
Of Semiconductor
Industry Experience**

**Our Experience
Started With The First
Commercial IC**

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plus
The Reasons Why**



Established in April 1989, Future Horizons provides market research, technical appraisal and industry analysis for use in due diligence opportunity assessment, business planning and new market development. Its industry information seminars and forums are widely considered to be the best of their kind. Emphasis is placed on the worldwide microelectronics and associated electronics industry and European market environment.



Malcolm Penn is the founder and CEO of Future Horizons, with over 50 years experience in all aspects of the IT industry, from semiconductors to end-electronics equipment; advance research to manufacturing and applications together with an extensive network of C-level industry contacts. He has worked extensively throughout Europe as well as in the United States, the former USSR, Japan and Korea, and was an early pioneer of pan-European research and product development collaboration in the 1970s during his tenure with ITT Europe.

His wide range of experience includes brokering partnerships and helping firms develop their joint activity relationships. Prior to establishing Future Horizons, he held various operations, marketing and business development positions in the semiconductor and IT industry having worked his way through university as a professional musician.



Mike Bryant is Future Horizons CTO. With more than 40 years in the electronics industry, he is an experienced RF and analogue/mixed signal IC design engineer, specialist in providing IC design and consultancy services on hardware and systems design partitioning, software and digital signal processing design methodology and implementation. Recognising the convergence of many software and digital hardware design techniques, Mike was one of the first in Europe to use HDL and.

In an era dominated by an abundance of 'free' web-based information and an infinite permutation of 'expert' opinions, from PR hype to bloggers, Future Horizons offers a high-quality, unbiased, flexible information-based service with justified analyses for key industry decision makers. For all of your semiconductor-based business development needs ...

Let Future Horizons Save YOU Time & Money

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