



GenRad

GenRad is Asia





*Robert M Dutkowsky
President, CEO & Chairman of the Board*

GenRad 虽然是一家全球性公司，但我们始终没有忘记客户要求我们在当地灵活地提供咨询和服务，使他们安枕无忧。我们重视亚太地区，在本地区进行了支持服务和可观的投资，建立了一个强有力的、经验丰富而工作协调的团队。他们是 GenRad 的“门面”，我为他们的工作感到骄傲。在这本案例册子里，我们希望向您详细披露我们亚洲客户的业务，听他们直接讲述我们如何帮助他们改进制造业务。

“ The expression ‘*It’s a small world*’ has many different meanings. For some, it is a chance meeting; an unexpected reunion of friends or colleagues. For others, it is the limits of our planet which drive us to find innovative solutions to problems of overcrowding and diminishing natural resources.

For GenRad it is the knowledge that the world is becoming a single marketplace in which business no longer recognizes the boundaries of language or distance and must adapt to the diverse communications and cultural needs of every nation. It’s a small world because technology allows us to communicate quickly and efficiently between continents.

Our customers have been quick to demand greater access to information, and support services which are available ‘just-in-time’. Our response is to fulfil these needs through greater use of the internet, investment in highly skilled engineers and a structured programme of training and continuous improvement in quality.

GenRad is a global company but we have not forgotten that our customers need the flexibility and reassurance of local people to offer advice and support. Our commitment to the Asia Pacific region includes considerable investment and effort in building a strong, experienced and cohesive team. They are the ‘human faces’ of GenRad and I am very proud of their efforts.

In this case study book we wish to offer you a greater insight into the work of our customers in Asia and hear direct from them how we fulfil our mission to improve manufacturing businesses. I would like to thank the customers and agents who took part in creating this report which truly demonstrates that GenRad belongs to Asia.

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"Acer is in a unique position in which it has the full range of capabilities needed, including cost-effective manufacturing of components, modules and communications systems, to play an integral part in shaping an Internet-Enabled digital world."

Stan Shih, Chairman, The Acer Group

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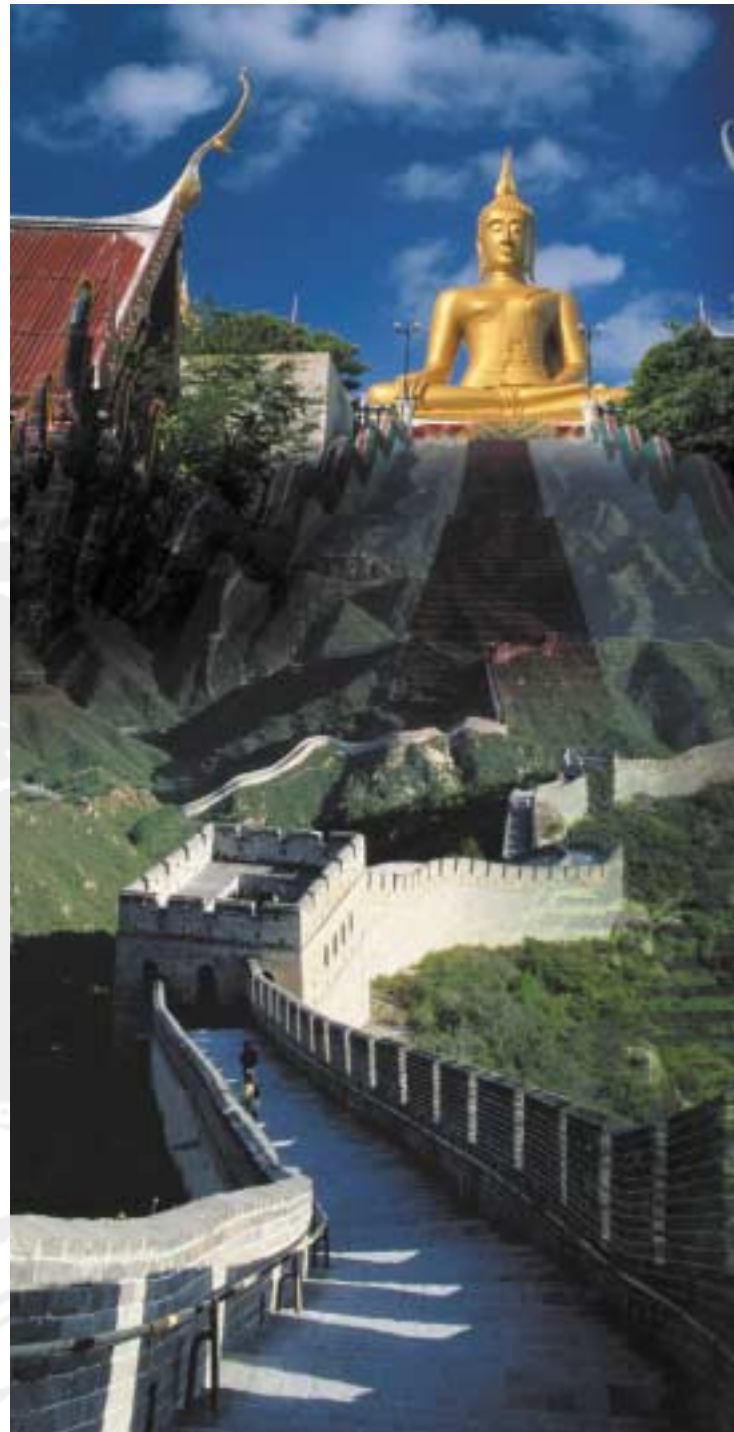
1995 World Bank Report

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"We are very thankful that GenRad provided excellent migration software and on-site training to match our previous supplier's tester in the Fujitsu Kumagaya factory."

Ricki Goto, Fujitsu





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"GenRad is an important contributor to our growing business, by giving us the expertise in test technology and the support that enables us to build fully integrated manufacturing services."

*Lee Lok Fui, General Manager,
Jurong Hi-Tech*



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"A unit which fails in the field could clearly mean the difference between life and death, so production and test are geared entirely towards one goal - zero defects."

*JS Park
Overseas Sales Team Leader*



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"Solidarity, Vitality and Customer Satisfaction."

Shanghai Bell corporate motto

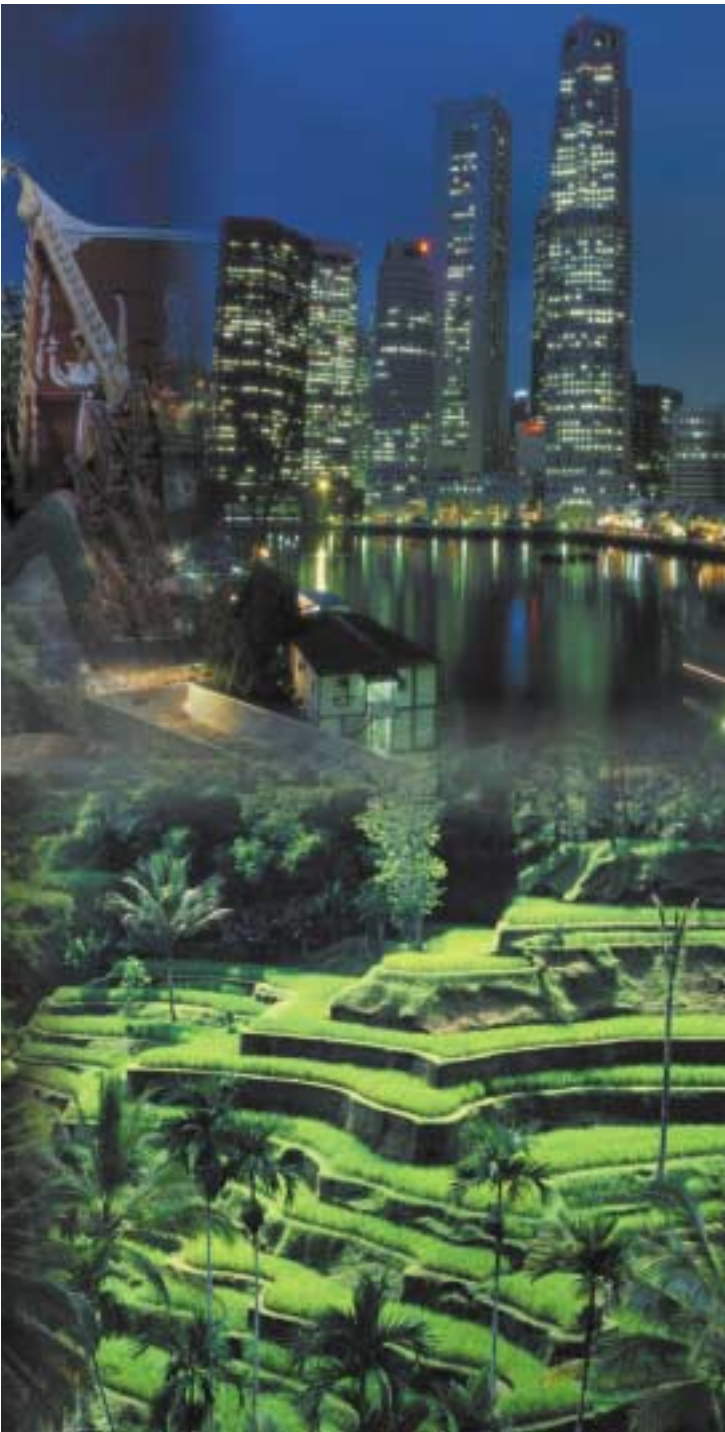


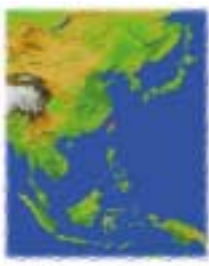
**YOUNG CHANG
KURZWEIL**

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"Dealers now insist that our products are certified as ICT tested on GenRad equipment - it has become the basis of our marketing campaign."

Y G Lim, Test Manager, Young Chang





Taiwan

A Bold Vision for the PC

“Acer is in the unique position in which it has all the capabilities, superior design and cost-effective manufacturing, to play an integral part in shaping an internet-enabled digital world.”

*Stan Shih
Chairman & CEO*

Few companies can claim expertise in the wide range of computing products manufactured by Taiwan's Acer Group. From its humble origins in Taiwan, the company has grown to become a top global player in the fiercely competitive PC marketplace, and provides jobs for 28,000 people worldwide. The company was ranked number 1 in an Asian superbrands awareness survey conducted by Readers Digest in 1999 and operates 21 manufacturing sites around the globe.

In addition to its core PC and laptop range, the company is leading the field in 'i-enabled' internet appliances, moving steadily towards a world of common communication and shared information. Among the many technologies either under development or in production are internet phones, 'I-walkman', cyber TV and 'smart' mobile telephones. Stan Shih, the company's charismatic Chairman and CEO describes this digital revolution as “100 times more important than the Industrial Revolution, it will be a 'social revolution' as it will be changing the way we live.”

GenRad has been working with Acer in Asia for more than ten years. The company originally

bought a GR2276 production test machine for the testing of its original desktop PC motherboards. Since then systems have been installed in Taiwan (4 lines), the Philippines (8 lines) and China (8 lines) to test notebook computers, mobile and video phones and a range of peripheral products. The motherboard production lines at Hsinchu run 24 hours a day producing 70,000 boards a month, 40% of which are used in Acer's own products, but the rest are produced on behalf of IBM and third party manufacturers.

Support for Acer's test programme comes from GenRad's local agent, Giantec. “Originally they helped with full program development and fixturing, but now we only require assistance with specialist program libraries and fixturing. Training is absolutely essential for us, especially in terms of setting up new facilities in China. For example, we currently have just 60 days to set up a new line in China, so finding and training employees will be difficult. GenRad will be able to support us locally,” says MK Chang, Associate Director at the Computer Systems Plant at Hsinchu, Taiwan.

“GenRad's software library gives much greater flexibility than other test vendors, particularly in areas such as boundary scan,” he says.

A typical product lifecycle in the computer world is no more than



9 months, 3 months to develop and prepare a new design and six months of production. Most of the design work is completed at the company's world headquarters in Taipei, but Hsinchu is responsible for test program development and deployment, so ease of use, reliability and local support are crucial.

“We have always developed our own production software and functional test equipment for PCs and memory products. However, the functional testing is the main production bottleneck. We can have up to 10 stations running functional test for each line with test times up to 13 minutes per board. Reducing this time is one area where we are cooperating with GenRad. Video and audio tests are the most difficult and most critical to PC production. In some instances we use low cost dedicated testers for this but a more uniform test platform will be the next step. We generally achieve a 95% first pass yield.”

And as PCBs are becoming increasingly more complex with greater density of components, Acer will need to move to a more distributed test strategy and greater focus on faster, more reliable functional testing. MK Chang is also looking at AOI and X-ray techniques as possible future substitutes for traditional in-circuit testing.

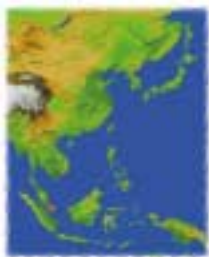
“Technology changes so quickly,” says Product Engineer Bryant Lai, “We cannot afford to stop working with new techniques and developing better manufacturing solutions. Internet appliances and wireless products will be a big challenge for us and will need to be adapted to the mass production model we are used to.”

Acer Milestones



- 1976 Company founded under the name 'Sertek' focussing on product design
- 1978 Established a microprocessor training centre to train 3000 engineers
- 1979 Designed Taiwan's first mass-production computer for export
- 1981 Established operations at Hsinchu, now one of the largest PC product manufacturing sites in the world
- 1984 Establishes peripherals and publishing ventures in Taiwan
- 1985 Retail operations established in Germany and Japan
- 1986 Acer beats IBM in the race to produce the first mass production 32 bit PC
- 1987 Company renamed as ACER and acquires Counterpoint Computers
- 1989 Original joint venture with Texas Instruments to develop DRAM modules
- 1990 Acer acquires Altos
- 1993 Acer develops first 64 bit architecture to link RISC technology with Windows
- 1994 Acer introduces the world's first dual Pentium PC
- 1997 Acer acquires notebook subsidiary of Texas Instruments to become the world's largest notebook manufacturer.
- 1998 Acer acquires remaining interest in Texas Instruments and becomes the Official Computer Sponsor of the 13th Asian Games in Bangkok
- 1999 Acer ranked Number 1 in Readers Digest Superbrands survey.





Tracking the Changes

"We had weekly meetings with GenRad to discuss technical issues and found TRACS easy to integrate with our functional testers. GenRad were very helpful."

Ng Huey Ching, Adaptec

No one can deny that computers and networking technology are now an integral part of modern life. They are at the heart of almost every process in businesses and homes throughout the world. And where there are computers, there is the vital need for fast and efficient communications. The ability to transfer information between different computers, operating systems and network topologies seems to grow ever more complex every day, with devices like printers, scanners, CD-ROM and DVD requiring faster and more reliable connections.

This is the need that Adaptec has filled since 1981 with products that move data between computers small and large. The company is a world leader for its local area network cards, modems and other peripherals, or as Adaptec describes it 'bandwidth management technologies'. Its products are incorporated into the systems of some of the world's best known computer brand names. One of its key technologies, SCSI I/O control cards, are produced in a country that boasts one of the world's most sophisticated information infrastructures; Singapore.

Visitors to Adaptec's Singapore manufacturing facility at the Chai Chee Industrial Park cannot fail to be impressed. Opened in 1999 and occupying over 2000 square metres the factory and test development centre is modern, clean and organised with typical Singaporean efficiency and since the plant employs over 700 staff and houses six state-of-the-art production lines, it needs to be. Maintaining high quality output and low field returns is a primary target and this is achieved by continuous investment in new technology and improved quality management systems. Not surprising then that the company regularly receives industry accolades, including the recent Singapore Quality Class award, for outstanding performance in the Asia Pacific region.

Adaptec 公司以其区域网络卡、调制解调器及其它电脑辅助设备而领先世界。它的产品装配在世界上一一些最著名电脑品牌的系统中。Adaptec 公司要求 GenRad 提供测试修理和控制软件。上述软件的优势包括：故障检测的平均时间下降到 30 分钟，只占原来的四分之一。

"In-circuit test and inspection are really important to us at Adaptec," says Test Development Manager Wee Chee Hong. The company has invested heavily in its test technology with six GenRad GR228X testers, configured with GR Accelerate and Philips in-line board handlers. A dedicated technical centre and test development team operates from the same building, developing customised functional test and inspection processes for the company's Singapore and US operations. Well placed lineside repair stations and a well equipped rework workshop handle defects with quiet efficiency but until recently the whole process had suffered from one problem. Chee Hong explains. "We used to collect test data from the lines manually, which could take one to two hours to analyse. We needed to react faster when a problem on the line was identified."





Adaptec turned to GenRad for a solution. After careful evaluation of the requirements of a single line, GenRad recommended TRACS (test, repair and control software). TRACS would enable the company to set up a central database of test data, collected automatically from the line in real time. By collecting data from both in-circuit and final functional test stations, it would be possible to identify line faults within minutes rather than hours. It had the added advantage of storing full manufacturing test data for individual boards, available at the press of a button, or swipe of a bar code. A two year process of evaluation and testing began in close co-operation with GenRad's engineers.

Associate Engineer in the test design team, Ng Huey Ching, commented on the project; "We had weekly meetings with GenRad to discuss technical issues and found TRACS easy to integrate with our functional testers. GenRad were very helpful." The relationship goes back to 1993 when the first GenRad testers were installed and depends on close technical co-operation and trust. This is essential where a manufacturer needs to integrate a complex generic product like TRACS with its own proprietary software.

The evaluation project has been a complete success. The most visible benefit is that fault detection has been reduced to an average thirty minutes (a quarter of the original response time), since TRACS reports recurring defects almost immediately on screen. However, faster response to line problems is by no means the only benefit. The software also provides real time warnings, keeping managers up to date on yield and highlighting boards with consecutive

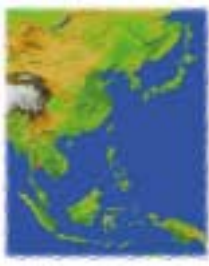
fails, so that no product passes through rework more than twice. Customised reports can provide information to managers, engineers and designers, both on-site and potentially to executives world-wide via the Internet.

The company has also found it useful to be able to look up specific results on individual boards, especially where field returns are reported, and have access to the original manufacturing data. "It has taken some time for workers to get used to using the database," said Chee Hong, "Especially using the mouse; they were used to writing things by hand before. But our long term goal is to run TRACS across all our lines."

In recognition of the close working relationship, Mr K Y Lim, President of Manufacturing and Executive Officer of Adaptec Inc. awarded GenRad "Best in Class" at the 2000 Adaptec Suppliers' Day.

It would seem that two years of hard work is now paying off, giving Adaptec the ability to offer an even better service in a fiercely competitive marketplace. Even a world leader like Adaptec cannot rest on its laurels. They have the vision to strive for constant quality improvements. The breakthrough in the computerised test yield tracking system is only one of the team's achievements. To date the Adaptec Test Engineering team has been accredited as the first PCBA operation with built-in on-line in-circuit and functional testing capabilities. The company's quality policy, proudly displayed as you enter the modern, air-conditioned building, could not put that vision more succinctly - *"We shall do it right first time."*





Thailand

The Global Provider

“By the year 2020, in terms of purchasing power parity, the Thai economy will be Number 8 in the world.”

1995 World Bank Report

Thailand has been one of the few South East Asia nations to survive and prosper under the recent economic depression throughout the region. A stable and forward thinking government has stimulated continued investment in industry, providing tax incentives and reduced tariffs for private sector business as well as creating investment opportunities. The policy of liberalization, privatization and decentralization has allowed electronics, automotives and telecommunications industries to flourish.

The demands of today’s competitive business climate are many: rapid product introduction, condensed product life cycles, tighter cost control and shorter lead times. To succeed in this volatile environment, today’s most successful technology companies rely on partnerships that can respond to these challenges in an effective, timely manner. One of the most successful manufacturers in the country to follow this paradigm is Celestica.

Celestica is the third largest electronics manufacturing services company in the world. Its customers include the leading original equipment manufacturers (OEMs) in the industry, primarily in the computer and communications sectors and the company offers

services to support a wide variety of customer requirements from low-volume, high complexity custom products to high-volume commodity products.

Celestica is a global leader in the electronics manufacturing services industry. With over 20,000 employees worldwide, the company operates 31 manufacturing and design facilities in the United States, Canada, Mexico, the United Kingdom, Ireland, the Czech Republic, Thailand, Hong Kong and China. Celestica provides a broad range of services including design, prototyping, assembly, testing, product assurance, supply chain management, worldwide distribution and after-sales services.

The company’s Thailand operation is in Chonburi, one of the country’s largest manufacturing zones, and was formed in January 1999 by a merger with International Manufacturing Services (IMS), an established local contract manufacturer. With 2500 employees, the company is the second largest in the country. It was Celestica’s 8th acquisition since it became independent from IBM in 1996.

“Today, you have to be global to compete. Celestica wanted a stable base in Asia and rather than build facilities on a “green field” site, it made sense to merge with IMS,” says Pichai Duangtaweesub, Director of Thailand

Celestica是电子制造服务业的世界领先者。该公司在全球的雇员超过2万人，在美国、加拿大、墨西哥、英国、爱尔兰、捷克共和国、泰国、香港及中国共有31个制造厂和设计处。该公司致力贯彻全面的测试策略，其80%在线测试设备与服务由GenRad公司提供。用于支持网络卡、电信产品和磁盘驱动器的生产的测试系统有20套以上。



ในปี พ.ศ. 2538 บริษัท
Celestica ได้เจริญเติบโต
ขยายกิจการออกไปทั่วโลก
เพื่อที่จะครองตลาดเป็นหนึ่ง
ในอุตสาหกรรมรับจ้างผลิต
แผงวงจรอิเล็กทรอนิกส์
โดยในปีถัดมาปี พ.ศ. 2541
Celestica ได้ขยายฐาน
การผลิตเข้าสู่เอเชียโดยการ
ผนวกเอาบริษัท IMS (Thailand)
เข้าเป็นส่วนหนึ่งของบริษัท
จากแผนการรวมกิจการทั้งหมด
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Operations and former Director of IMS for 5 years before the merger.

“Celestica has provided the business with a global infrastructure, improved reputation and wider range of services that we can use to support our customers here in Asia. We are able to provide a foothold for the whole Asia Pacific region, and provide Celestica with a low cost manufacturing facility for some of its worldwide customers. We do this in cooperation with our suppliers and partners, including GenRad.”

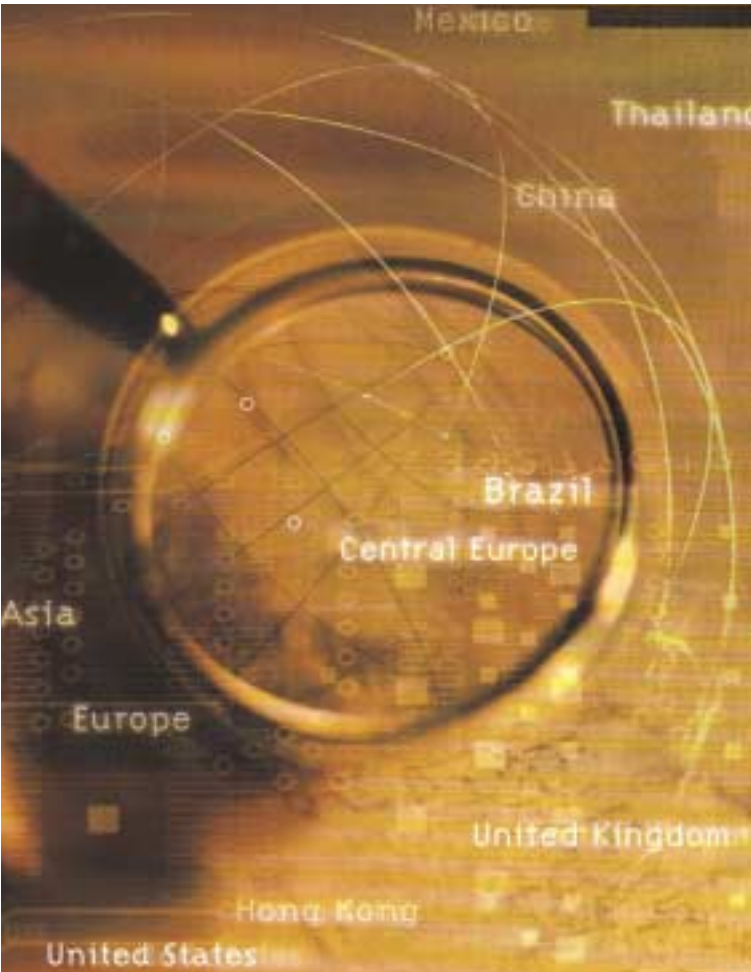
“Even prior to the merger, the company was committed to a comprehensive test policy, with in-circuit test equipment supplied and supported by GenRad. GenRad supplies the local support and training we need. It is a long term and very successful partnership. For example, GenRad were recently able to provide Boundary Scan training for an engineer in Singapore, followed by local training. They also assisted with urgent debugging and engineering change orders on request at anytime.”

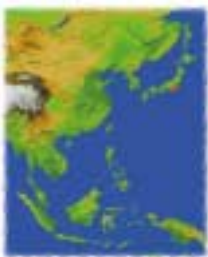
GenRad’s Thailand Operation Manager, Chukiat Boonkorkoer explains how the partnership operates, “GenRad sales and support in Thailand is through our agent, Niche Tech. They are able to give all the necessary technical support, which we combine with in-depth training in Singapore. The arrangement increases the amount of resources available to the customer. We try to provide the very best even for customers which have only one system. Niche Tech plays a big role in getting closer to customers, identifying requirements and providing solutions.”

An investment in software runs

alongside the company’s commitment to test hardware. Celestica has been running proprietary monitoring software on one of its lines for some time, gathering quality data for its SAP based MRP system to improve manufacturing processes and throughput. “Customers are demanding more and more information about quality and yield. We have to find ways of providing this information.” says Pichai.

Pichai claims the future for Celestica in Asia is very bright. “The company invests in the very best engineering skills and our employees are committed to the corporate goal of continuous improvement, with set training programs. A new plant is being built in Malaysia to provide additional capacity. I am happy to say that GenRad will continue to be one of our partners here in Asia.”





Banking on Future Technology

“Customer focus is really about solutions that are conceived from the customer's point of view. It also means a committed programme of Environmental Protection Activities and Social Contribution.”

Riki Goto, Manager of PCBA Testing

Fujitsu is a leading provider of Internet-based information technology solutions for the global marketplace.

Comprising over 500 group companies and affiliates worldwide, including ICL, Amdahl and DMR Consulting, it had consolidated revenues of 5.26 trillion yen (\$49.6 billion) in the fiscal year ended March 31, 2000.

Fujitsu's pace-setting technologies, world-class computing and telecommunications platforms, and global corps of over 60,000 systems and service experts make it uniquely positioned to harness the power of the internet to help its customers succeed.

Altogether, the Fujitsu Group has 188,000 employees and operations in over 100 countries.



From mobile computers to high-speed communications to interactive multimedia, Fujitsu companies are working to realize the Infinite Possibilities of information technology.

We spoke with Mr Riki Goto, Manager of PCBA Testing at the Kumagaya plant, Japan, about the company's business philosophy, manufacturing strategies and plans for the future.

Mr Goto, The 1999 Annual Report for Fujitsu says ‘Customer Focus’ is the key to the future. What does that mean for your operations in Kumagaya?

Goto: “At Fujitsu Kumagaya we believe that “Customer Focus” means providing highly-reliable products and good services to customers. That can translate down to the production floor. For example, we have achieved ISO9001 certification, we evaluate all parts of the factory's quality maintenance system and all 860 employees here are involved in improvement and initiative activities relating to all aspects of our products and business through a “High Reliability Program” based on group activities.”

“Customer focus is really about solutions that are conceived from the customer's point of view. It also means a committed programme of Environmental Protection Activities and Social Contribution.”

Fujitsu is a big group of companies with very diverse operations. Does this help you in sharing of knowledge, resources or people from one division to another?

Goto: “We hold periodic technical meetings at Fujitsu's head factory at Kawasaki to exchange

富士通是因特网信息技术方案的全球领先供应商。富士通集团在100多个国家开展业务，雇员逾188,000名。最近，该公司替换了安装在日本Kumagaya工厂的许多测试系统，由GenRad提供了设备和关键的“转换”软件。



technical information in each factory. Moreover by offering timely technical information through the internet, Fujitsu can determine world trends and quickly re-examine the product line.”

How do you tackle the pressures of quality, cost-reduction and complexity in modern PCB production?

Goto: “The Kumagaya plant produces PCBs for banking terminals in financial institutions, ATMs, point-of-sale terminals and PC cards. Therefore our PCB's are high in density and also very complex. Quality requirements are very demanding because the products are for financial institutions and so we must maintain all processes to the ISO9001 standard.”

“There are always pressures to reduce costs and all around the plant, day and night, improvement activities are encouraged. Six workers from the plant constitute a team and they go around to each of the shop floors looking for signs of waste and promptly design improvements on the spot to thoroughly eliminate any waste they find. We also run a DFM (Design for Manufacturing) program to carry feedback requests from production to design. This is a continuous process.”

Do you have high levels of automation or CIM facilities?

Goto: “The production line used to be fully automatic, but is now more flexible to shorten lead-times from R&D to manufacturing. There still remains an automatic area to reduce operator's burden.”

What was the main reason for replacing all previous test systems with your current suite of GenRad solutions?

Goto: “Primarily because of the obsolescence of our former tester. There were no compatible

systems on the market and we selected a platform that provided the greatest flexibility in future development.”

“GenRad provided excellent migration software from the previous system. There were no problems in converting fixtures to the new system and GenRad's agent in Japan assisted us greatly in the conversion to the new systems. We are very thankful for the migration software and on-site training supplied.”

Apart from ICT, what other tests do the products undergo during production?

Goto: “We perform a variety of analog tests (electric current, voltage and waveform) along with ‘hot-bed’ functional testing using instruments developed in-house.”

Products are becoming smaller, more complex and more integrated. How will this affect your production and test strategy in the future?

Goto: “It is becoming more and more difficult to find space for test-pads on current PCB layouts. Test program libraries sometimes take time to catch up with new integrated circuits such as LSIs.”

“Our cost and throughput targets are such that we would like to continue using ICT as our main test strategy and we look for suppliers such as GenRad to find innovative solutions in this area.”



富士通はインターネットを基本としたインフォメーション・テクノロジー・ソリューションのグローバル市場の主要プロバイダーです。富士通グループ全体の従業員数は188,000人、世界100ヵ国以上における拠点でビジネスが展開されています。最近、同社の熊谷工場のテストシステムが一新されたのですが、その際、GenRad社のテストシステムとプログラムが多数採用されました。





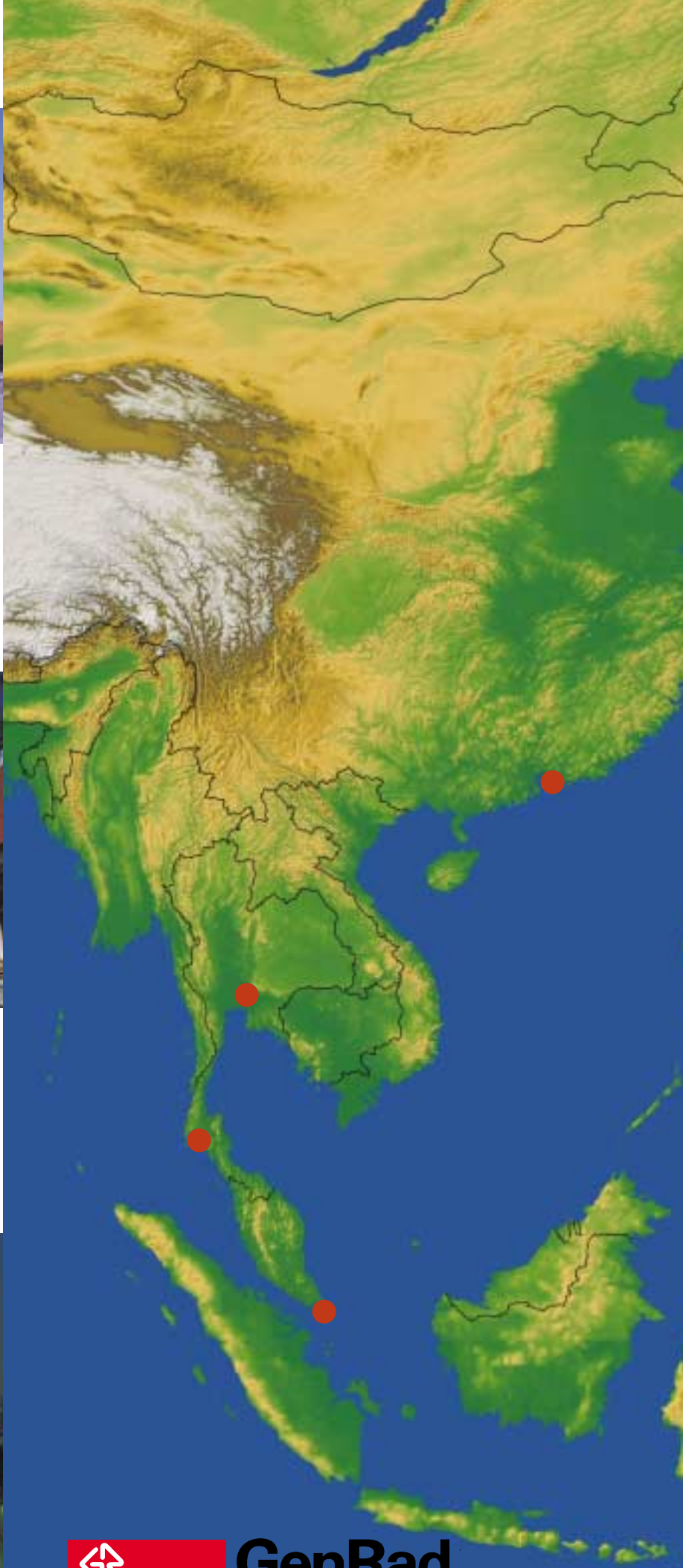
*The Forbidden City
Beijing, China*



*Temple of Buddha
Samui Island, Thailand*



*Financial District
Singapore*





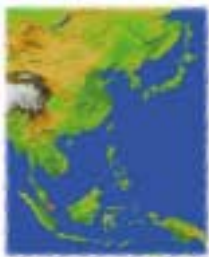
*Tokyo at Night
Tokyo, Japan*



*The National Flag
of South Korea*



*CKS Memorial
Taipei, Taiwan*



Preparing for Expansion

“GenRad is an important contributor to our growing business, by giving us the expertise in test technology and the support that enables us to build fully integrated manufacturing services.”

Lee Lok Fui, President, Jurong Hi-Tech

Jurong Hi-Tech is part of the Jurong Technologies Industrial Corporation, a S\$90 million contract manufacturing operation with low and high volume printed circuit board assembly (PCBA) and box build services.

The company's origins lie in the development of automation for the shipping industry which began in 1986 and the company still manufactures these products from its original base at the Jurong shipping yard, Singapore. The increasing demand for PCB assembly led the company to establish independent operations in 1988 and shortly thereafter won a contract with Western Digital to manufacture hard disk drive PCB's. Since then Jurong Hi-Tech has gone from strength to strength, building a core of high quality clients such as Maxtor for hard disks, and Creative Technologies, Mitsumi and Kenwood for audio and video products. 80% of the company's production is hard disk units although growth in video and audio products is increasing. New, high speed facilities for SMT and BGA assembly were introduced recently and the company is fully accredited to the ISO9002 standard.

The company's Singapore plant occupies 18,000 square feet and runs seven lines, six of which are

SMT facilities. A further twelve lines are installed in 32,000 square feet at Cemerlang, Johor in Malaysia. Altogether the company employs 800 people with a production capacity of 50,000 boards per day. With this kind of throughput per day, quality control is vital to maintaining high yields and the backbone of the company's test strategy is eight GenRad 228x ATE systems. The 228X series is GenRad's high performance family of production test solutions. Ideal for complex, high productivity applications with mixed signal, digital, analogue and functional test requirements, the high pin count and fault coverage make it the very best on the market. Test program generation is also flexible due to the adoption of Windows NT as the operating system and GenRad's unique range of design to production programme development and debugging tools.

The man in charge of engineering is Lok Kum Fook. “Our customers typically introduce a new product every quarter with a lifespan of no more than six months, so it is crucial that we are able to get new products into production quickly. We aim to bring new products into full production within two weeks and this can only be achieved by having a strong, well equipped test development team in-house.”

The team has established facilities for design of full ICT test programming, including vectorless tests for ASIC's, and fixture development and this is one of the areas where GenRad provides valuable support. Often, customers' functional test requirements are also developed in-house using IEEE instrumentation.

“With the very long term relationships we have with our customers, our manufacturing facility becomes an extension of their operation. Customers want to know more about the process, cost structure, yields and so on. We particularly

Jurong 高技术公司是 Jurong 技术实业集团 (Jurong Technologies Industrial Corporation) 的一员，按合同生产的低、高容量印制电路板组装 (PCBA) 和制箱作业高达 9 千万新加坡元。本公司奉行不断改善生产过程的目的；员工致力于每月开发一个新项目。这个新项目可能是工作自动化系统、改善工作流程或管理或评审生产战略。新项目的重点总是力求为用户服务增添价值。





work together in the design cycle, assisting them with component selection and reviewing artwork and layouts to gain maximum benefits from our assembly and test facilities. Obviously we have an intimate knowledge of our customers' products, so we can adapt very quickly to new designs," says Lok Kum Fook.

The company operates a policy of continuous process improvement - committing the workforce to one new development project per month. This might be a factory automation system, improvement in workflow or management practice or review of production strategy. Always, the focus is on adding value to the customer service offering.

Growth has been so rapid (averaging 50% per annum for the last three years) that the company

Business Milestones

- 1988 Initial plant set up in Jurong, Singapore
- 1991 Rapid Expansion following manufacturing contract with Western Digital
- 1992 Established 6000 sq ft factory in Jahor Jaya
- 1994 Moved to 23,000 sq ft factory in Cemerlang and awarded ISO9002 certification for Singapore
- 1995 Established a further plant in Selangor
- 1996 ISO9002 accreditation for Johor plant, Malaysia
- 1998 Introduced new high speed technologies and awarded Outstanding Supplier by Maxtor
- 1999 BGA volume production commenced and awarded Strategic Contract Manufacturer status by Creative Technologies
- 2000 Listed on Singapore Stock Exchange in April 2000

is now preparing itself for an Initial Public Offering (IPO) on the Singapore Stock Exchange. Company President, Lee Lok Fui explains the rationale behind the move to go public.

"We cannot stand still at this time and in order to fulfil demands from new and existing customers we have chosen to adopt an aggressive expansion programme. The IPO will allow us to expand facilities in Asia to offer more integrated services, as well as forming alliances in Europe."

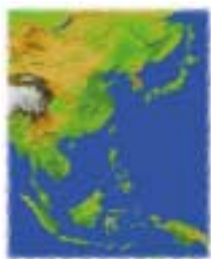
GenRad's contribution to the business is far greater than just the supply of ATE equipment and fixturing services. Training and after sales services are important to fully maintain and gain the best from the 228X series systems. GenRad also assists with continuous improvement projects - advising on test and repair issues, failure analysis and program development.

"GenRad's process knowledge has been invaluable in helping us develop new opportunities in the wireless and cellular communications industry," comments Lee Lok Fui, "GenRad is an important contributor to our growing business, by giving us the expertise in test technology and the support that enables us to build fully integrated manufacturing services. In our business, communication between plants is becoming more and more important. GenRad are one of the few suppliers who are able to provide consistent, high quality training and support across the Asia Pacific region. As we develop our Eastern European alliances, that relationship will become even more apparent."



Awards received from Maxtor (Outstanding Supplier Award 1998), Western Digital (Excellent Supplier Award 1994) and Creative Technologies (Strategic Contract Manufacturer Status 1999)





Korea

Korean Life Savers

"A unit which fails in the field could clearly mean the difference between life and death, so production and test are geared entirely towards one goal - zero defects."

*JS Park
Overseas Sales Team Leader*

Fifty-six years ago, Kia started building bicycles in Korea. A nation of tired bicyclists soon demanded motorized vehicles. So that's what Kia built. First motorcycles. Then trucks. And, of course, cars. At last count, more than 2,000,000 Kias have rolled off the factory floor and on to the roads in more than 170 countries around the world. Founded in 1944 as a manufacturer of steel tubing and bicycle parts, Kia quickly evolved. The company became the first Korean company to build internal combustion engines and the first to build passenger cars. Its Hwasung manufacturing plant now covers more than 3.3 million square meters and has the capacity to produce more than 1,000,000 vehicles annually.

Behind the glamour of the motorcar industry however, lies a highly technical and experienced group of research, design and manufacturing operations.

Bontec Co. Ltd. is Kia's electronics manufacturing subsidiary, established in 1993 from the merger of two smaller companies in collaboration with Alpine, the Japanese manufacturer of audio, video and navigation systems. Its facilities are based at JinChun-Gun, to the South of Seoul. The factory employs 380 staff in the production of in-car audio visual entertainment units, remote locking systems and electronic control units (ECUs) for a variety of automotive functions used in all Kia automobiles. The JinChun Factory is 164,000 square feet in size and has almost all the facilities along with R&D laboratories to run the entire business operations. Almost all the products produced there except a few items for export are supplied to Kia Motors, and that includes 600,000 audio systems, 300,000 airbags and 300,000 wiring harnesses.

The development plan for new products is clearly defined, and Kia's long term goal is to integrate many of today's digital technologies into its vehicles of the future. For example,

起亚(Kia) 是韩国第一家轿车厂商, 年产量超过100万辆。但是, 在光彩夺目的汽车行业的背后, 是一系列高技术、有经验的研究、设计和制造作业。Bontec Co. Ltd. 位于汉城南部JinChun-Gun, 是起亚的电子品生产子公司。这家工厂有380名人员, 生产包括安全气囊在内的几种轿车设备。用于PCB测试的GenRad 228x系统具有一系列功能和测量技术, 最适合复杂的用途。





“We are the only manufacturer of airbag ECU's to test to the NHTSA International Standard, and we are required to undertake product liability tests for all products exported by Kia,” explains JS Park.

“In manufacturing terms we achieve only 0.3% failure at ICT stage and zero failures after final functional testing.

current audio technologies such as DVD, MP3 and Mini-disc will converge towards a common in-car digital video standard. The personal digital assistant you carry in your pocket today will one day plug into your car, to facilitate in-car navigation, planning and communications. Safety features are also expected to improve using futuristic techniques such as head-up displays used by fighter pilots and voice control.

A major line at the factory is the ECU which controls vehicle airbags, first introduced in November 1995. JS Park, the company's Overseas Sales Team Leader explains the project:

“We began developing our own airbags partly due to the partnership with TRW in the United States. The Airbag Integrated Electronic Module (AIEM) consists of an accelerometer which senses any changes in speed and triggers airbag deployment when impact shock exceeds a predefined threshold. The unit contains a built-in power supply which enables all functions to be maintained even in the case of loss of main battery power. Reliability, performance and advanced features are thanks, in part, to the use of ASICs which perform all critical functions within the circuit.”

The manufacturing line currently produces 40,000 units per month, with the capacity to double this if required. A unit which fails in the field could clearly mean the difference between life and death, so production and test strategy is geared entirely towards one goal - zero defects.

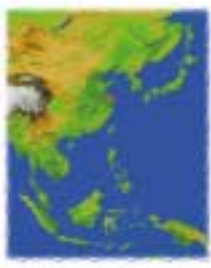
Achieving this requires reliable and accurate test systems. GenRad's 228x system is the main platform used,” says H O Yoon, Assistant Manager in the ECU Technical Team. The 228x systems in use have a very wide range of functions and measurement techniques, making it ideal for complex or mixed signal applications. Additional capabilities include ASIC, PAL and FPGA test program generation.

“GenRad has provided training for our engineers in Singapore, much more convenient than travelling to the United States,” remarked H O Yoon.

Kia has won numerous accolades for its superior achievements in quality control. It was the first automotive manufacturer to receive Korea's Total Quality Control (TQC) Grand Prize at the 17th annual National Quality Control and Standardization Contest in 1996, the Korean equivalent to Japan's famous Deming Prize and America's Malcolm Baldrige Award. Bontec was also the first manufacturer to receive the Grand Prize from the President for Quality Control management in Korea's 100 PPM Quality Management Competition in 1998.

Continuous research and development is the backbone of the company's philosophy and the company's history has involved several partnerships, most notably the relationship with Alpine, and technical partnerships with Yazaki (Japan) and TRW (USA). Given the company's rapid growth and considerable achievement, it would seem to be the philosophy for success.





China

Leading the Telecom Revolution

“Solidarity, Vitality and Customer Satisfaction.”

Shanghai Bell corporate motto

Over the past twenty years China has reformed and developed into one of the fastest growing economies in the world. The transformation is clearly visible in the telecommunications industry. The rapid development and investment in digital networking, ISDN, frame relay and GSM technology has narrowed the gap with the rest of the world and China's telecoms infrastructure is fast becoming one of the most sophisticated on the planet.

One of the pioneers of this process is Shanghai Bell Company Ltd, founded in 1984 as a Sino-Belgian joint venture. The company employs more than 2600 people. Voted regularly in the top ten of the country's "National Joint

Ventures", the key to Shanghai Bell's success has been shrewd and careful development of technical partnerships and joint venture projects. These include businesses in the Philippines, Vietnam, Iran, Russia, Norway, Australia, Germany and Hong Kong. The company sees exports as a vital part of its operations, manufacturing individual products for overseas markets as well as bidding on turnkey projects. As a result of consistent high standards, Shanghai Bell was awarded ISO9001 quality certificate in 1995 and predicts that 20% of its sales revenue will come from export markets by the end of this year.

The backbone of Shanghai Bell's product range is the S12 series switching systems, which can link to analogue and ISDN customers for local and long distance exchanges. S12 has been installed in over 3000 exchanges and 40 million lines throughout China, and exported to many other countries, representing some 35% of the domestic market. In addition to manufacturing digital switching systems, the company is also involved in the fields of wireless and data communication, working closely with Beijing

中国的电信基础设施正迅速成为世界上最尖端的技术。这一进程中的先驱之一就是上海贝尔有限公司。该公司于1984年由中国和比利时合资建立。它有2600多名员工。与GenRad进行密切的合作是为了保持其位于上海浦东金桥出口加工区最大制造中心的高质量水平。





Post and Telecommunication University to develop China's first generation ATM, among other successes. In accordance with the company's policy of significant reinvestment in research and development (currently 6-9% of sales revenue), extensive work is being done in the areas of GSM, ADSL and the company is engaged in the development of a new generation of CDMA wireless switching systems, primarily aimed at the mobile phone market.

Shanghai Bell has made great efforts in the localisation of its products. With annual output of 6 million lines of the S12 J family, its largest manufacturing centre, located in the Jinqiao Export Processing Zone in Pudong, was put into operation in 1995. The production base is extensive, including an assembly and testing workshop equipped with SMT lines, wave soldering and test facilities. The centre also includes a Piece Parts workshop, concerned with the manufacture of PCBs and large quantities of metal and plastic parts for the S12 system and uses CNC laser cutters, welding robots and its own water and waste processing systems. Through the localisation work, Shanghai Bell has introduced and merged advanced technologies from abroad as well as introducing new management models and information systems, all controlled under the ISO9001 quality system.

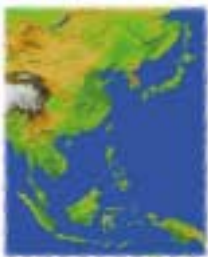
A typical example of this success is the unit producing the S1240 Programming Control Switching System. They have seven SMT lines, including DEK printers and FUJI assembly machines. With production volume currently at 6 million lines (around 45% of the China market for such systems), accurate and timely testing is crucial. The unit uses four GenRad in-circuit test

stations (the GR2286, GR2283 and GR2284) with plans to integrate further units in the near future. Shanghai Bell chose the ICTs to gain maximum fault coverage, high throughput, reliability and accuracy over previous MDA-based testing. In the words of Zhu Jian "As you know, we are always improving things and this can create frequent variations during manufacturing. GenRad's system gives us a lot of manufacturing information which helps us. In the first phase of development we cooperated closely with GenRad." The unit manufactures over 100 board variations. Fast development of software and fixtures, as well as fast response are important benefits in the use of a well-integrated system such as the GR228X series.

Having recently celebrated its 15th anniversary, Shanghai Bell is looking forward to the future with confidence and says it will stick to its motto of "Solidarity, Vitality and Customer Satisfaction". Gunther Strobel, General Manager, recently said "The industry is one of the key factors in our country's rapid economic growth. And is also one of the country's key infrastructure activities, like roads, railways and air routes. We have to go to different areas we've already been active in, such as switching and access products, to gain new market share with new products."

In an effort to provide even higher levels of service, the company has not only set up service centres overseas, but also vendored technical training services to foreign customers. With modern information technology and the satisfying service of the new age, Shanghai will enter the new information millennium hand in hand with customers and partners worldwide.





Making Music in Korea

“Dealers now insist that our products are certified as ICT tested on GenRad equipment - it has become the basis of our marketing campaign.”

Y G Lim, Test Manager, Young Chang

A fine piano is an investment that will enrich the quality of life. The design and craftsmanship of the piano is an art steeped in old world tradition dating back over three centuries.

Young Chang is a relative newcomer in an industry where many of the leading manufacturers are well over 100 years old. After only 40 years or so, the South Korean company has grown to become one of the largest piano manufacturers in the world, with the capacity to produce more than 135,000 pianos in a year.

Young Chang's heritage represents the innovation and skill of three individuals whose obsession was to create excellence. It was in 1956 that the Kim brothers, Jai-Young, Jai-Chang and Jai-Sup, combined their financial, musical and engineering talents to create South Korea's first musical instrument manufacturing company.

Just 15 years after assembling its first piano, Young Chang began exporting world-class pianos and became the first non-Japanese musical instrument manufacturer, and one of only a few piano manufacturers to be awarded the prestigious Japanese Industrial Standards mark for consumer product quality assurance. A second factory was opened in Incheon, Korea, in 1976. The 680,000 square-foot factory was

completed in late 1979. The early 1980's saw exports exceed US \$10 million, recognized by an export award from the Korean government. Young Chang founded European, US and Canadian operations in 1984, and in the same year became the first public corporation in the Korean music industry.

Young Chang entered the digital keyboard market by acquiring selected assets of Kurzweil Music Systems in 1990 and now develops, manufactures and markets both professional and home digital keyboards under the Kurzweil brand name.

Kurzweil Music Systems Inc. was founded by inventor Raymond Kurzweil, who had developed a revolutionary reading machine for the blind. Musician Stevie Wonder, a customer for the reading machine, challenged Ray Kurzweil to create an electronic instrument that blended the richness of acoustic sound with the control and sound modification of electronics. The Kurzweil engineers then developed the first ROM-based sampling keyboard to successfully reproduce the full complexity of acoustic instrument sounds - the K250. The music industry was astounded by its ability to emulate a piano, strings, choirs, drums and other acoustic instruments with extraordinary accuracy. Since then, electronic musical instruments have had a new benchmark of quality for which to strive.

The acquisition of Kurzweil brought with it a range of manufacturing and logistical problems, as

自从15年前装配第一台钢琴以来，Young Chang公司开始出口钢琴，并成为第一家因消费品质量保证而获得显赫的日本行业标准标记的非日本乐器制造商。该公司生产世界上最受推崇的电子钢琴之一，但在出现质量保证方面的问题后向GenRad求援，第一个GR228x系统于1997年安装，在此后的三年内，该公司的电子故障几乎降低为零。





Kurzweil's K2600 synthesizer offers 400+ programs, state of the art interactive sounds, effects, 8 sliders, 2 wheels, 5 pedals and breath controller.

explained by Hal Chamberlain, Senior Systems Engineer based in South Korea and the man charged with managing the manufacturing process.

“In the early 90’s Kurzweil struggled with quality problems. PCB’s were assembled without quality standards or adequate test procedures. We had a few oscilloscopes for component testing and repair, but ultimately the product was tested on assembly. If it made musical notes, it was passed. However, production people were not musicians and many keyboards were making their way to the dealer showrooms and even into the customer’s hands with serious defects affecting the performance and sound of the product. Piano players were far more critical of minor defects affecting the sound quality of the instrument - defects which the manufacturing engineers were unable to identify. We embarked on a project to persuade the Korean management to implement In-Circuit Testing (ICT), arguing that the cost of replacing and repairing faulty keyboards was already affecting the company’s performance and reputation.”

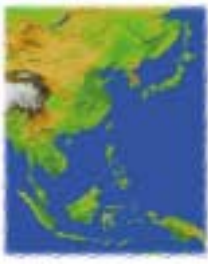
The result was a \$20 million investment which included GenRad test equipment and the start of a three year project to radically restructure test facilities as explained by Y G Lim, Test Manager at Young Chang.

“GenRad was selected for several key reasons. The Windows NT operating environment was crucial since test programs are generated at the research and development office in Waltham,

USA, but debugging takes place at the manufacturing centre here in Korea. Engineers required a consistent platform working under accepted industry standards. Since the company produces in excess of 12,000 boards per year, each with an average component cost of \$2500, fast throughput is important, with high fault coverage. Over 40% of the cost of each instrument is electronics. GenRad’s test machines provide MDA, ICT and functional test options which suit the complexity of the Kurzweil products. The GenRad testers are also now used to program ASICs, PALs and flash memory chips during production; devices which play a key role in the keyboard. The program code which creates even the most basic musical sounds is over 4 Mbytes and we offer hundreds of add-in sound files or memory modules which can be installed or downloaded from the company’s website.”

The first GR228X tester was installed in 1997 and over the following three years, the company has reduced electronic failures in the field to virtually zero. “Almost all of our repair problems are now mechanical,” says Chamberlain, “And usually relate to wear and tear rather than manufacturing defects. Our ICT facilities have become the first stage in a rigorous test process which includes manufacturing defect analysis, verification of component values and placement, electronic test and precise audio tests which measure frequency response and distortion in the sound of the keyboard. We will often replace components which fall *within* the manufacturer’s tolerances in order to create a





more accurate sound. Final functional testing is performed after box build to verify the sound quality as well as the action (ie: the feel of the keyboard when played.)”

By the year 2000, Young Chang had regained the confidence of the professional piano playing market and dealers were showing such interest in the manufacturing side of the product that the company used its test strategy as the basis of a new marketing campaign, offering products as ‘certified ICT tested’.

Raymond Kurzweil has long since left the company, but Kurzweil’s reputation continues to grow as new technologies are developed and Kurzweil engineers sample new sounds from around the world, using state of the art digital technology to add to the sound library. Today the Kurzweil product line features a wide array of electronic instruments for both the home and professional musician.

Kurzweil Music Systems’ Professional Products continue to be the choice of leading musicians, recording studios and institutions because of Kurzweil’s critically acclaimed sound library, extraordinary functionality, and industry-leading technology. In addition, Kurzweil Digital Home Products offer consumers the same world-renowned Kurzweil sound quality as the professional products, plus handcrafted cabinets and top-quality built-in audio systems. It is tempting to claim that GenRad was *instrumental* in creating this world class musical success!

Awards



- 1991 Music Magazine in the USA (KEYBOARD)
“The World’s Best Digital Piano”
- 1992 Music Magazine in Japan (KEYBOARD)
“The Best Keyboard of This Year”
- 1993 Music Magazine in the USA (MIX)
“Technical Excellence and Creativity of This Year” Award
- 1995 Music Magazine in France (Le Monde de la Musique) “The World’s Best Digital Piano”
- 1995 Music Magazine in the USA (MIX)
“Technical Excellence and Creativity of This Year” Award
- 1996 Music Magazine in the USA (MMR) “The Best Digital Piano in 1995”
- 1996 Music Magazine in the USA (EMM) “The Best Synthesizer” Award
- 1997 Music Magazine in the USA (MIX)
“Technical Excellence and Creativity of This Year” Award
- 1999 Music Magazine in the USA (MIX)
“Technical Excellence and Creativity of This Year” Award



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