

CASE STUDY

United States of America

Flextronics International – San Jose Mobile Phone Testing

Telecom

SoundCheck™, Ear Simulator, Calibrators, Microphones

FLEXTRONICS

was originally founded in 1969. With its corporate headquarters in Singapore, it's today one of the world's largest and most profitable providers of electronic manufacturing services with an annual revenue of more than \$10 billion.

Flextronics provides advanced engineering, design, manufacturing and distribution services to leading original equipment manufacturers (OEMs) throughout the world. A main focus is the manufacture and assembly of mobile phones and Flextronics uses the SoundCheck™ system for production line testing at its manufacturing sites around the world.



The Company and its History

Flextronics was launched by Joe McKenzie in 1969. Today, it's a \$10 billion global company and is one of the world's leading electronic manufacturing services providers building complete products that range from complex printed circuit board assemblies for computer workstations to personal digital assistants.

Initially, Joe McKenzie and his wife provided an overflow manufacturing service to Silicon Valley companies. At the heart of most electronic products is a printed circuit board, an insulated shelf upon which semiconductors of various shapes, sizes and functions are mounted. The connecting circuitry is manufactured into the board so that once the parts are mounted, the assembly becomes a working device. Companies that needed more boards than they could produce in-house sent their overflow work to Flextronics, where all the parts were hand-soldered onto the boards and then returned as finished goods.

Cost Reduction

In 1980, Bob Todd became CEO and put the company on the path that led to today's multi-billion dollar business.

Bob changed the face of both Flextronics and the industry. The company became a contract manufacturing firm – a name that to this day identifies its core industry. The company also pioneered automated manufacturing techniques to reduce the labour-intensity costs of assembly. Flextronics instituted board-level testing to assure that quality and yield targets were met. And in 1981, the company was the first American manufacturer to go offshore, setting up the Flextronics Singapore facility – still the worldwide corporate headquarters Flextronics International Singapore Pte. Ltd.

Turnkey Solutions

By the mid 1980s, Flextronics started to deliver turnkey solutions. Customers create a product specification and send it to Flextronics. Everything from the manufacturing process to the buying of parts was handled by Flextronics. The customer validates the plan, but no longer did it dictate the process. Furthermore, to serve this growing trend, Flextronics offer computer-aided design (CAD) capabilities. Customers come with an idea and Flextronics designs the entire printed circuit board. As an added benefit, component testing is provided so the individual parts can be assessed and quality assured. Flextronics growth continued and it moved into “full-box assembly” – the contract manufacturer's term for building a complete, working, shippable product.

A Global Business

During the 1990s, Flextronics acquired over 12 operations, built a global infrastructure for high-volume manufacturing, expanded purchasing and engineering capabilities, grew from 3000 employees to over 13 000 and increased the revenue target to \$5 billion. One of the driving strategies that has enabled Flextronics to focus on such a high revenue target is the company's unique Industrial Park model. Located in Asia, Europe and the Americas, these parks co-locate suppliers on the same factory estate where manufacturing takes place, resulting in greater operational flexibility and responsiveness to customer needs. Another unique service is provided by Flextronics' Production Introduction Centers (PICs). Throughout the world, these facilities design, prototype, test and launch the production of new products, shortening critical time-to-market.

In February 2000, Flextronics' revenue exceeded \$5 billion. The company is one of the world's largest and most profitable providers of electronic manufacturing services. It offers advanced engineering, design, manufacturing and distribution services to leading OEMs, including such household names as Cisco, COMPAQ, Hewlett-Packard, IBM, Motorola, Nokia and Philips. Today, just the name Flextronics communicates the speed, flexibility and excellence that is its core – a sophisticated, intelligent and bold organisation that achieves the customers' desired results with complete global solutions.

San Jose, California

The Flextronics facility at San Jose employs more than 1000 people and undertakes low, medium and high volume manufacturing. And it's big – the site extends to some 406 108 square feet (37 727 square meters).

There are two production lines that manufacture both standard and customised products. There are also extensive R & D resources that design the mechanical and electronic specifications of products manufactured by Flextronics.

Engineering Expertise

There's a wealth of technical expertise at Flextronics, San Jose – an example of the company's dedication to achieving the highest standards for its products.

Fig. 1
Left to right:
Bob Kunz, Stefan
Larsson and Rob
McClure



Rob McClure has worked at Flextronics for nearly four years. He has a Master's degree in electrical engineering and has been closely involved in the digital design and system integration of mobile and speaker phones.

Stefan Larsson has a degree in electronic engineering. He's worked for Flextronics for two years, both in Mexico and San Jose, works with software and hardware design and is a test engineer.

Bob Kunz has degrees in Criminal Justice and Computer Science. He's worked in the electronics industry for 20 years, including companies such as Rockwell and Motorola, and came to Flextronics seven years ago. Bob's prime responsibility is the development of test systems and he is the manager of the mobile phone testing project.

Mobile Phone Testing

Fig. 2
A testing station
showing two test
boxes, power
amplifiers and a
power supply



Flextronics manufactures mobile phones at its facilities in Malaysia, China, Mexico and at San Jose. Bob Kunz explains, "We needed a fast production-line testing solution to test the audio quality from the mobile phone's loudspeaker. Testing speed was driven by the capacity demand from one of our major mobile phone customers".

Flextronics designed and built the test boxes. Each test box contains a Brüel & Kjær Type 4192 ½-inch Microphone and a Type 4185 Ear Simulator for Telephonometry.

The artificial ear is specially designed to fit the physical profile of the mobile phone case and ensure that no audio leakage occurs. "We're very pleased with the quality of the ear, and the delivery time was quite short", says Bob.

Stefan Larsson adds, "Mobile phone manufacturers frequently change their designs and introduce new models. One great advantage of our system is that we only need to have a new ear mould made to fit a new mobile phone design. This is very cost-effective and it only takes seconds to interchange the artificial ears".

Fig. 3
A Type 4185 Ear Simulator for Telephonometry is attached to a Type 4192 Microphone in one of the test boxes



Flextronics chose the SoundCheck™ system from Listen Inc. – a solution marketed worldwide by Brüel & Kjær. Bob Kunz says, “We have used Brüel & Kjær products for many years and we got excellent references on SoundCheck™. We gave the details of our testing needs to Brüel & Kjær and they quickly offered us exactly what we wanted. Our mobile phone customer was also pleased with our choice – their very specific testing demands are a path that leads right to this solution”.

“We got the system we wanted in the right time-frame. Given the factors of quality, price, specification and risk, it was the obvious choice”.

Stefan says, “It’s easy to set new testing parameters in the SoundCheck™ system when we want to test a new mobile phone model so it’s very flexible”.

Fast

Rob McClure adds, “SoundCheck™ is a fast and efficient testing tool. One person can operate both test boxes and the data from these is fed into one PC. It takes less than three seconds for the test to be completed. We mount the phone using a simple press fixture and the total time for loading and unloading each phone is less than 10 seconds. Although this is a currently a manual operation, it could be automated quite easily”.

Simplicity and Reliability

The specification for the loudspeaker test was established by the mobile phone customer.

Fig. 4
The operator interface is very simple: Examples of the GUI from left to right: Select the required function, Pass, Fail



Rob continues, “The Brüel & Kjær/Listen system has now been running for 1½ years and it’s been completely reliable. The SoundCheck™ software runs in the background and the operator interface is really simple. There’s a basic screen where the operator selects the required function. Another screen is displayed while testing is in progress, and then the operator sees a simple pass or fail display. The operator does not need to have any acoustics skills or training. If a loudspeaker is rejected, the test data can be used to provide important information to the loudspeaker manufacturer and help him to improve his production process. So everyone wins – the manufacturer gets less rejections and so do we!”.

Bob Kunz says, “One of the great benefits of SoundCheck™ is that test times are very short, and of course, this greatly increases throughput, efficiency and saves money”. Bob continues, “We get great on-going support from both the local Brüel & Kjær office, and also from Steve Temme at Listen Inc.”

Fig. 5
A Brüel & Kjær Type 4231 Calibrator is attached to the microphone in one of the test boxes



To date, Flextronics has bought six SoundCheck™ systems for mobile phone production line testing at manufacturing sites around the world.

Calibration

“We calibrate the microphones every day” says Rob McClure. “In fact it’s not needed because they’re extremely stable but it give us confidence to do it, and it’s part of the test specification. We use a Brüel & Kjær Type 4231 Calibrator”.

SoundCheck™

LISTEN Inc. was formed by Steve Temme. Steve has been associated with Brüel & Kjær for many years, and using his vast electroacoustic knowledge and experience, Steve has developed a highly versatile, software-based system for the production line testing of electroacoustic devices, loudspeakers, microphones, hearing aids, telephones and other acoustic transducers.

SoundCheck™ runs under Windows® (95/98/2000/NT®) and comprises a series of “Virtual Instruments”. This means that no special hardware is required as the system operates using a standard professional sound card and a standard PC equipped with a Pentium® processor.

Fig. 6
A mobile phone is placed in the fixture, ready for testing



SoundCheck™ has been optimised for fast production testing and evaluation, and performs very rapid frequency response and distortion tests, typically in less than 2 to 4 seconds. The system evaluates frequency response characteristics of the transducer using swept sine or noise-based tests. Harmonic distortion, and also special distortion parameters such as Rub & Buzz (an evaluation tool for poor speaker/enclosure installations) can also be measured. The number of distortion components that can be measured is practically unlimited,

and the HarmonicTrak™ algorithm ensures that test speed is not compromised by the addition of harmonic distortion analysis. Furthermore, impedance measurements can be performed and various optional loudness calculations can be made, based on the frequency response measurements.

PASS/FAIL criteria are easily set or changed and the PASS/FAIL status is shown clearly after each test run, showing which test parameters are within the defined tolerances. The system also provides extensive tools for statistical evaluation of the production output.

Customisation

SoundCheck™ is easily programmed and is delivered with a range of options that automate testing. The operation sequences required by each customer, e.g., user prompts, conditional branching, and non-keyboard commands, are easily accomplished using the Sequence Editor software. All the accessories necessary for on-line production

control, such as foot-switches, buzzers and barcode readers, are supported and can be easily installed. SoundCheck™ can be controlled by (or can control) LabVIEW™ applications/virtual instruments, and programmes supporting ActiveX®, if required by the customer.

Space-age Success

For a year prior to the worldwide agreement with LISTEN Inc., SoundCheck™ has been successfully marketed by Brüel & Kjær in North America. Manufacturers of mobile phones, loudspeakers, hearing aids, universities and independent testing laboratories have purchased systems for a wide range of applications. Both NASA and the U.S. Navy have chosen SoundCheck™ for the evaluation of their communications systems, as well as many loudspeaker manufacturers using it on their production lines worldwide.

Stefan says, “SoundCheck™ is written in LabVIEW™ – we also use it extensively so this gave extra benefits. First, we understand the software and second, if required in the future, we can easily integrate our own programmes with it but it’s not necessary to be familiar with LabVIEW™ to configure SoundCheck™.”

Certification and Accreditation

The Flextronics’ San Jose facility is accredited to:

- ANSI/IPC-A-610
- BABT
- CE
- CSA
- FDA Quality System Regulation (CFR 21 Part 820)
- ISO 9001
- ISO 14001
- Nemko
- TÜV/VDE
- UL Approved

Key Facts

- Flextronics was founded in 1969 – today, the worldwide corporate is in Singapore
- Flextronics is one of the world's largest and most profitable providers of electronic manufacturing services with an annual revenue of more than \$10 billion
- The company provides advanced engineering, design, manufacturing and distribution services to leading original equipment manufacturers throughout the world
- The Flextronics facility at San Jose employs more than 1000 people and undertakes low, medium and high volume manufacturing
- A main focus is the manufacture and assembly of mobile phones
- Flextronics has used Brüel & Kjær products for many years and it got excellent references on SoundCheck™
- SoundCheck™ is easily programmed and is delivered with a range of functions that automate testing
- Flextronics uses the SoundCheck™ system for production line testing of mobile phones at its manufacturing sites around the world
- “SoundCheck™ is a fast and efficient testing tool”
- To date, Flextronics has bought six SoundCheck™ systems