This is your life

Caswell – the cradle of the semiconductor industry. By Helen Duncan.

Sometimes history produces a conjunction of factors that foster an unprecedented burst of technical innovation in one location. It’s a phenomenon famously identified in the growth of Silicon Valley.

But it’s not just a US phenomenon: a similar effect occurred much closer to home during the mid to late 20th Century – Plessey’s Allen Clark Research Centre at Caswell, now owned by Bookham Technology.

It is recognised that both the GaAs mesfet and the GaAs monolithic ic were invented and developed at Caswell, but what is probably less well known is that scientists on the site were working on silicon ic technology almost 18 months before Jack Kilby demonstrated the first working ic at Texas Instruments.

Caswell technologists also developed the first multilayer ceramic capacitor and a host of other inventions that enabled many of the electronic products we rely on today – including mobile phones, satellite tv, WiFi and RFID.

Many influential names in today’s electronics industry began their careers at Caswell and a huge number of successful companies owe their technical and commercial success either directly or indirectly to Caswell developed technology.

Early years

Despite its reputation for semiconductor research, it was passive devices that were the main focus when Plessey first moved its research laboratories to Caswell in October 1940, in order to escape enemy bombing around London. At the time, the site comprised a country house with a working farm, situated four miles from the small market town of Towcester. Pigs and geese continued to be a feature of the environment until the mid 1950s, when the labs outgrew the farm buildings and the first purpose built structure was added.

The laboratories were run by Geoffrey Gaut, an ambitious and forward thinking scientist who had joined Plessey as a new graduate in 1934. Projects under way at the time of the move included: the miniaturisation of electrolytic capacitors; cobalt ferrites for magnetic recording tape; high power variable resistors; and semiconducting ceramics and high temperature ceramic/metal composites (cermets).

An early breakthrough was the invention in 1948 of Radar Absorbent Material. This technology, later dubbed ‘Stealth’ by the US, went on to provide a crucial tactical advantage to British naval and airborne forces in the Falklands and both Gulf Wars. It is still being developed and manufactured in Towcester as part of BAE Systems.

Work on solid state silicon crystal growth and purification began at Caswell in 1952 and this formed the basis both for rectifier production in Towcester and for development programmes during the 1950s and early 1960s in radiation detectors, photocells and solar cells. Even the term ‘solid state’ was invented at Caswell, to distinguish semiconductor devices from their valve predecessors.

Kilby himself
acknowledged that it was Geoffrey Dummer of the Government’s Telecommunications Research Establishment (TRE, later RSRE) at Malvern who first suggested the idea of the ic in 1952, as a result of discussions with Gaut at Caswell. In April 1957, TRE granted Caswell a research programme towards realising a silicon ic and a wooden space model was fabricated there by John Herbert to demonstrate the concept. Considerable work had already been completed on integrating resistors and inductors by the time one of the key engineers, J T Kendall, left Caswell to work for TI. It was only months later that TI announced the realisation of the world’s first ic.

Silicon ic development began in earnest at Caswell in 1958 and continued until 1991. The focus was mainly on analogue circuits, particularly amplifiers. By early 1963, it had achieved a six transistor feedback amplifier chip operating over dc to 5MHz. Many world class linear devices developed at Caswell were transferred into production at the Plessey Semiconductors plant at Cheney Manor in Swindon, which had opened in the mid 1950s to manufacture transistors.

If silicon dominated Caswell’s research projects during the 1960s, then compound semiconductors, particularly GaAs, became the flagship technology of the 1970s and 1980s, spawning a manufacturing unit in Trowcester. Scientists at Caswell developed the first reliable technique for producing GaAs in thin films – the arsenic trichloride vapour phase epitaxy process – and this enabled it to achieve world leadership in Gunn diodes in the late 1960s.

In 1970, the late Jim Turner announced the world’s first commercially available GaAs fet operating in the low MHz frequency range. The following year, he reported 3µm gate length fets on GaAs with an fMAX of 50GHz and useful gains up to 18GHz. Turner led the team that included Ray Pengelly who, in 1976, demonstrated another world first – the GaAs monolithic microwave integrated circuit (mmic). Pengelly left Caswell in 1986 and is now strategic business development manager with Cree in the US.

Dr Fred Myers joined Caswell in 1968 to work on two terminal GaAs devices. By the time he left in April 2002, he was responsible for all of the semiconductor activity on site. Myers believes Caswell’s history of innovation was influenced strongly by leadership from the top, with most managers having already made significant technical advances before being given management responsibility. This was an essential element in stimulating progress in a research environment.

Derek Roberts, who succeeded Gaut as director of Caswell and later went on to run GEC’s Hirst Research Laboratories, was an early leader in silicon technology, along with Herbert and the late Bill Holt. Other influential figures included chief scientist Bryan Wilson, the late George Gibbons and John Bass, who managed the site after Roberts’ departure.
Caswell recruited a wide spectrum of talent, ranging from ‘mad scientists’ to those with a more practical outlook. This exciting atmosphere kept Caswell in the top three of the world’s research establishments for many years, a position that only began to slip in the 1990s, when the push for more immediate return on investment by GEC management curtailed the longer term research that Plessey had always managed to support.

The GEC-Siemens takeover in late 1989 saw Caswell lose the title ‘Allen Clark Research Centre’, to be renamed GEC-Marconi Materials Technology. It continued to play a leading role in GaAs research, now targeted at commercial applications such as satellite TV and emerging wireless technologies such as cellular infrastructure and wireless LAN.

A further change of direction occurred in 2002, when the Caswell site was acquired by Bookham Technology. At first, it seemed that Bookham would continue the manufacture of GaAs ICs for RF and microwave components, for which there was considerable demand as wireless broadband was a growing applications sector. But it announced in 2004 that it was shutting the GaAs line at Caswell to concentrate on InP optical components.

“We are still producing great technology at Caswell,” said Andrew Carter, Bookham’s chief technology officer. “It is all now focused on optical chips for telecom applications, with key differences from the early days being yield, time to market and the ability to ramp production for global demand. Everything is now quicker, leaner and more predictable.”

The Caswell legacy
Many Caswell alumni have made their mark in academic roles, including Prof Mike Cardwell at Aston University, Prof Tom Brazil at University College, Dublin, Prof Ian Robertson at the University of Leeds, and Dr Chris Oxley at De Montfort University.

Some of Caswell’s compound semiconductor expertise can now be found at RFMD in Newton Aycliffe (formerly Filtronic Compound Semiconductor), whose managing director Dave Smith had worked at Caswell for more than 25 years before relocating, along with several colleagues.

Plessey’s two terminal GaAs devices moved to GEC-Plessey Semiconductors at Lincoln in 1989 and Gunn diodes are still manufactured there by e2v.

The legacy of custom mmic design in the UK continues at Plextek, which has recently equipped a new clean room to perform RF on wafer testing up to 50GHz. Liam Devlin, director of RF integration at Plextek, who began his career at Caswell, commented: “Plextek has designed more than 40 different ICs for a range of clients and applications and is one of the world’s leading full custom GaAs IC design houses. It’s a great shame there is no longer a foundry in the UK where we can produce them.”

Steve Cripps became known as a world expert in power amplifiers while working at Caswell and went on to be a founder of Celeritek in the US. He now runs design consultancy Hywave Associates in Somerset.

Caswell’s silicon technology has a similar rich legacy. GEC-Plessey Semiconductors was taken over by Mitel in 1998 and subsequently renamed Zarlinck in 2001. The Swindon facility, however, was sold to MHS in 2008 for a nominal £1.

The custom IC design tradition is being kept alive by Peter Saul, who runs Saul Research, a design consultancy specialising in analogue and mixed function ICs in CMOS and SiGe bipolar technologies.

IRISYS, a Northampton-based company specialising in infrared technologies, was set up by David Clayson, who had previously worked at Caswell. Meanwhile, Caswell’s IR team became part of BAE Systems and is now based in Southampton.

The future of innovation
The ingredients that sparked Caswell’s impressive record of innovation would be difficult to reproduce today, with company finances too strictly controlled to allow pure R&D.

Ian Eddison, formerly at Caswell and now a management consultant, has described this as the ‘missing mezzanine’ effect, which is being addressed in a number of ways, including Knowledge Transfer Partnerships. Prof Brazil at UCD also cites academic/start up clusters as an attempt to emulate the ‘Caswell effect’.

But perhaps the final word should go to Jamie Urquhart, who began his career at Caswell, before going on to become a founder of ARM and then to venture capitalism with Pond Ventures. “Caswell’s funding came from a combination of UK Government sponsorship, internal Plessey funding and European funding. Most importantly, there seemed to be some overall strategic planning behind this. While the current Government makes assistance available to start-ups, it is not clear whether we get real value for money. There needs to be a long term strategic view of the electronics industry – from education through research to industry.”

“We cannot – and should not – squander our achievements with an ad hoc approach, but should build on the rich legacy of the past to achieve even more.”