
Date: 11 April 2016

# Foreword

EA Technology's first 50 years can be characterised by just one word: innovation. We were established in 1966 to advance the science and engineering in the distribution and use of electricity. Our founding raison d'être, therefore, required us to attract highly creative people to work in collaborative teams, to change how things were done. For our first 25 years we retained this focus on research and development as part of the nationalised electricity sector and were responsible for developing and delivering dozens of new methodologies and technologies which spanned the electricity networks, industry and many homes across Britain. Some of those innovations are reviewed in this commemorative book, produced to celebrate our first 50 years.

Privatisation of the electricity industry in the early 1990's saw a decade of a different kind of innovation as the organisation evolved into several smaller commercial enterprises, the largest of which became EA Technology Ltd. The evolution from a publicly funded research institute, to a commercially focused technology solutions business, required real change to the culture, leadership and skill sets within the company. Growth in our 5th decade reflected our ability to adapt.

The growth we experienced was significantly due to developing our international footprint. In 2016, we have members of the EA Technology team working in the UK, Germany, Abu Dhabi, Bahrain, Saudi Arabia, Singapore, China, Australia, New Zealand and the USA. Internationalisation has been key to our success, not only in expanding our operations and our ability to invest, but also in developing new technologies based on seeking out global best practice. These expanded horizons continue to shape both what we deliver to customers and our operational culture.

Our ownership profile has also been a story of adaptation. Initially publicly owned, the company became owned by management and staff in the early 1990's and then was bought by the employees in 2004. In 2016, this continues to evolve with the potential for some devolution of ownership to operating subsidiaries being considered to facilitate targeted investment and local incentivisation.

Our future is bright and is likely to be characterised by continued innovation, whether in geographic development, the solutions we develop and deliver, our ownership profile or our people. Without question, the energy sector is one of the most exciting areas for innovators in the world right now. The challenge of reducing energy costs, increasing reliability of supply and reducing carbon emissions, combine to create a fertile landscape for the amazingly creative and motivated people of EA Technology. Consumer electronics have delivered huge advances in communications and sensing which will progressively migrate into utility operations. Distributed intelligence will drive a re-skilling of our workforce. Integration into multi-vector energy management across heating, gas, electricity and transport will drive the development of new systems and technologies. Localisation of energy generation, distribution and consumption will see changes in the structure of the market place.

For the fleet of foot, this will be a playground of opportunity. For the innovative, a chance to re-shape the world. We will embrace the challenge and do what we do best.

Here's to the next 50 Years of Innovation!

# Contents

## Appendices

# 1. A Technology Retrospective – Our Pedigree

## 1.1 Helping British Industry

An important aspect of EA Technology's role in its early years was the research and development of new techniques and processes which were well proven and effective for industrial deployment.

This contributed hugely to increased production efficiency, output, safety, and cost reduction across British Industry, a legacy of which we are rightly proud.

### Metal Melting

The progressive development of more energy efficient electrical techniques was essential for the metallurgical industries. We were instrumental in our development of new techniques in steel making in the 1960's and in helping non-ferrous foundries melt metals such as aluminium in the 1980's.

### Steel

Steel was a major British industry during our early years. Innovations in the use of the electric arc furnace led EA Technology to develop new methods of reducing flicker.

### Iron foundries

We developed FURSIM, a state of the art computer program which allowed users to accurately access furnace energy consumption and cost. In the 1980's, we developed techniques which allowed the industry to melt steel scrap rather than costly pig-iron.

### Non-ferrous Melting

EA Technology helped the aluminium industry reduce metal losses and significantly reduce their costs through the use, for example, of an efficient coreless induction furnace. We also developed the cost saving high power channel induction furnace by redesigning the furnace heating loop.

### Metal Working and the Environment

Our developments in electrical rather than fossil fuel fired melting techniques have afforded cleaner and cooler working practices. In the 1980's we also turned our attention to noise and vibration reduction in the melting process.

### Metal Working and Shaping

Since its inception, EA Technology successfully developed a number of energy efficient techniques for heating metal prior to working or hardening, leading to energy savings of up to 30%. The transverse flux aluminium annealing line and the multi-layer coil have since been installed worldwide.

### Glow Discharge Heating

This electrical phenomenon had many potential applications such as the heating of rod and wire and was intensively researched and developed by EA Technology.

### Superplasticity

In the late 1960's, we became involved in worldwide research into superplasticity because of the process's need for electrical heating. We played a role in the construction of advanced commercial and military aircraft including Concorde and the A310 European Airbus. A symposium in 1969 held at Capenhurst led to British Aerospace becoming interested in our work.

### Metals forming

We developed technologies to position heat with greater accuracy, as part of its research into methods to allow solid metals to be produced commercially direct from metallic powder or scrap.

These included the glow discharge electron beam and a single stage electro-deposition process.

### Hardening and Coating Processes

The glow discharge phenomenon was the key to the development of a range of processes aimed at producing high quality surfaces at the lowest possible cost. In the mid 1980's, we developed a range of commercial plasma carburising furnaces.

### Helping Electricity Future Growth

By 1986, we were looking ahead to increasing electricity's share in the industrial energy market, particularly in the food and chemical production sectors. Innovations such as our dished electrode membrane (DEM) cell, and the electric rotary induction kiln were key.

## 1.2 Conserving energy and resources

Electrical processes and techniques are inherently clean and energy efficient. EA Technology worked towards actively conserving resources and preventing pollution even further through Electrochemistry.

### Sewage and Effluent Treatment

The VO2 Venturi Aerator was one of our major product developments. Other techniques using electrolysis, hydrogen bubbles and ozone proved innovative in dealing with industrial effluents.

## Metal Recovery

In 1973, EA Technology began working on a product which could economically recover valuable metals from electroplating and photographic processes. The Chemelec Cell became a significant commercial success.

It was followed by the etchant regeneration cell which minimalised pollution as well as recovering copper from solution, as 99% pure highly saleable metal.

## Electric Traction

This was part of EA Technology's research programme right from the start. In 1972, the world's first sodium-sulphur battery powered road vehicle, a Bedford van, featured on BBC's Tomorrow's World. Our groundwork lead to the development of the BETA cell in the 1980's, designed to give higher reliability over greater distances on a single charge.

## Heat Pumps

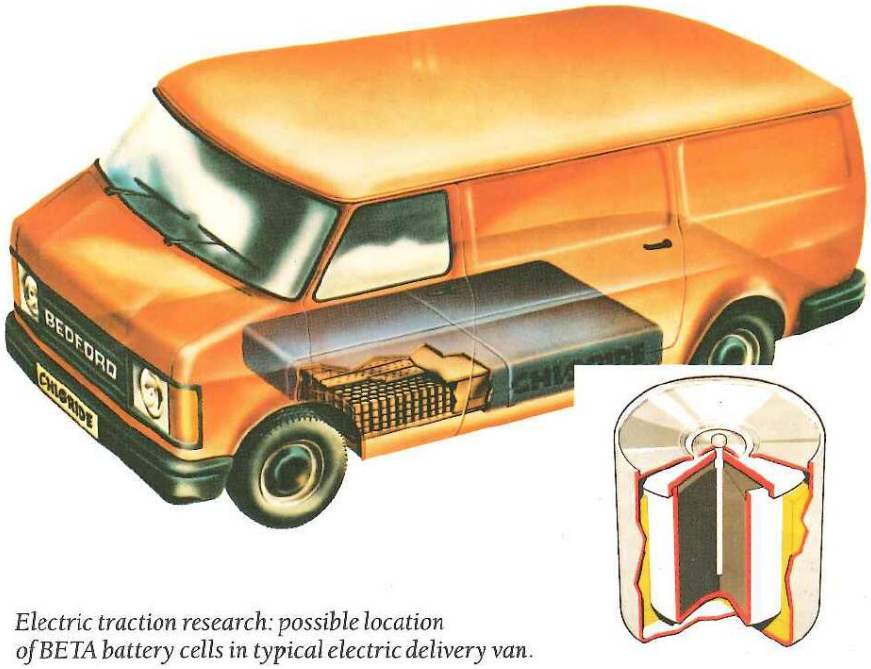
The 1973 oil crisis prompted EA Technology to start researching the electric heat pump, providing energy saving cooling systems to offices, shops, restaurants and hotels.

By 1979, EA Technology had developed electric heat pumps offering up to 65% energy cost savings to industry also.

Research was concentrated on raising working temperatures of the heat pump up to 150 degrees celsius.

A number of alternative heat pump applications were also developed, including HiTrec and systems for use in the brewing and distilling industries.

High intensity aerobic reactor using VO2 aerators at Cadbury




*Electric traction research: possible location of BETA battery cells in typical electric delivery van.*

## 1.3 Radio frequency and microwave research

EA Technology developed radio frequency (RF) and microwave drying techniques as key areas of research.

They had a significant impact on both scientific thinking and attitudes within industry.

Research began in the early 1970's and lead to both techniques being widely recognised as having industrial potential across the UK and beyond. RF became a subject for both undergraduate and post graduate university study.

EA Technology enabled the installation of a number of RF moisture profile dryers in paper and board mills, with consequential increases in throughput and better energy efficiency.

A joint project between EA Technology and a division of the Paper Industries Research Association showed that production losses could be prevented by radio frequency fields, employed at the correct power at specific production points. Laboratory results and computer predictions were operationally proven at a commercial level.

The textile industry also benefitted from EA Technology's research and development in these fields.

Using RF to dry wool was shown to have significant advantages. Compact radio frequency dryers dried in a fraction of the time and afforded a much more consistent moisture content.

EA Technology also developed radio frequency heating techniques for a variety of other operations, many of which were successfully installed.

We also used RF to complement existing drying systems, prompting research into a single compact unit, giving the economic advantages of conventional heating with the improved performance of RF - the Air Radio Frequency Assisted Dryer or ARFA. These dryers were installed in the UK, North America and Japan for such applications as drying textiles and board.

ARFA helped reduce drying times and led to a 50% cut in the reject rate and a 15% increase in throughput. This led to research into its potential applications for the food industry.

Research in the mid to late 1980's dealt with the use of RF to melt fats and waxes, including edible oils. This technique helped maintain product quality throughout production.

ARFA dryer bound for Canada

## 1.4 Electricity in the Home and at Work

In the 1980's, expectations about standards of living and working were rising. We were at the forefront in developing effective and economic electrical heating equipment and fostered new attitudes towards energy efficient house design.

### Feolite

We developed this high performing heat storage material which in the 1980's, was employed in 90% of night storage heaters. Feolite enabled the heaters to be 50% smaller than their 1960's counterparts. Heater sales rose from 62,000 in 1976 to 500,000 in the financial year 1985/6.

Slimline storage heater containing feolite.

## Energy Efficient Housing

In 1968, six test houses were built to study the thermal performance of occupied dwellings. A team of physicists, engineers and an architect worked on the project earning international recognition for scientific papers produced, documenting their findings.

Three simple design principles emerged; that the house must be heated using off-peak electricity, have a lower structural heat loss than conventional designs and incorporate a system of ventilation control. The team were asked to collaborate with Granada TV on the design and construction of a 'house for the future' for a television series.

In 1986, higher standards of insulation and ventilation were adopted by UK national house builders; an evolution from years of our intensive research. In the same year, the team were working on an advanced domestic heat pump dehumidifier which they hoped would be part of the future of energy saving house design.

## Home Heating Research

We worked on several products which although technically feasible, had elusive commercial success: the Electricaire warm air system, the Hullrad open heat pipe and the Vacrad controlled output storage radiator were amongst these.

We developed Centralec in the 1960's , which was the forerunner to the successful Nightstor in the 1980's, a compact central storage unit.

We also worked on thermal storage walls and reflective wallpaper, ideas way ahead of their time.

## Cooker Technology

In the late 1960's, EATL was active in the development of an entirely new way of cooking with electricity; using infra-red lamps shining through a glass ceramic hob. Although work on this project ended in 1971, it's importance did not go unnoticed by British appliance manufacturers. Further development by Thorn EMI, based on our acclaimed principles, led to the Haloheat hob.

## The Workplace

Resources were continuously dedicated to amassing evidence to prove the case for a better working environment, investigating levels of heat, light and air freshness; innovative for their time.

## Lighting

We won praise and awards for our expertise in this area. Our research contributed to many national and international guides and standards, including the Chartered Institute of Building Services Code for Interior Lighting. Work included examination of the effects of higher and lower lighting levels, flicker from fluorescent tubes, and revisions to escape route lighting levels in open plan offices. Uplighting was another area of research, with a uniformity of luminance report being published and adopted by the Chartered Institute of Building Services.

## Cook-Freeze Catering

These experiments were pioneered in our own on site restaurant with staff and visitors as the guinea pigs! We endeavoured to utilise the principles of quick freezing, cold storage and various reheating and final cooking techniques. We were able to offer wider menus and reduce running costs. EATL's early research into cook-freeze cooking techniques and benefits led to their widespread adoption. In 1986, our restaurant was still serving 30,000 meals a year.

## 1.5 Distribution Engineering and In-House Research

From our very beginning, a quarter of our research capacity was devoted to the reduction of electricity cost whilst maintaining reliability and quality of supply. This work included solving specific problems raised by individual electricity boards and sometimes required board engineers and EA Technology scientists to collaborate on new techniques which had the potential to revolutionise particular aspects of distribution technology. In the mid 1980's, we were directing our efforts towards the development of diagnostic equipment and techniques to help the boards manage their ageing systems. We called upon a selection of sophisticated analytical equipment such as electron and optical microscopes and X- ray facilities. Research often led to new instrument development.

### Improving Supply Reliability cost effectively

We pioneered the concepts of failure prediction and capital expenditure planning.

### Pole Replacement

We developed a portable machine to assess pole ultimate failure strength by applying a bending force. We also completed research into the assessment of corrosion resistance in metal conductors and the testing methods of corrosion detection in tower footings.

### Cables

We investigated materials which resisted the phenomenon of 'water trees'; defects in polymeric cables. We made recommendations to the electricity supply industry accordingly.

### Connectors and Clamps

Studies conducted in the early 1970's led to EA Technology's design criteria and testing procedures being widely adopted in the 1980's, concerning the electrical stability of mechanical connectors and clamps for aluminium cables and overhead lines.

### Keeping Costs Down

By 1986, we were developing instruments to help the boards keep operational costs down: the TEV discharge locator and the automatic sectionaliser.

### Locating Faults Faster and Cheaper

We took full advantage of the revolution in microelectronics to produce a range of fault location products, which by 1986, were widely used in the UK and overseas, including the Visitrace.

### Capenhurst Innovation Spanning the Globe

In the early 1970's, we were acknowledged as the developers of the world's first computer-aided high voltage cable testing and fault locating module. Equipment included the Impulse Current Fault Locator and the Microcomputer Fault Recorder.

### Lightning

Lightning is the biggest single cause of loss of supply and we were continually reviewing methods of protecting the distribution system. In 1986, we were establishing our lightning flash locator system, to record 99% of all activity and provide the Central Electricity Generating Board with lightning data within minutes.

### System Disturbance

Microelectronics helped in the development of a wide range of test instruments, capable of detecting power system voltage fluctuations and disturbances.

## Helping the Navy

We had two commercially successful harmonic analysers up to 1986; the first in 1972 which contained more than 6,000 components, and it's microprocessor based replacement in 1981 called The Robinson Type 555. This was used by the Naval Electrical Engineering Division of the Royal Aircraft Establishment to obtain statistical harmonic data regarding seaborne power supply systems.

## Monitoring Voltage Variations

Our Negative Phase Sequence Recorder used a single chip microcomputer to record data and supply it in digital form to either a printer or a cassette recorder. It was aimed at users of medical equipment, computers and scientific instruments.

## Flicker

We spent four years developing the Power Disturbance Analyser to give arc furnace plant operators alerts that they were in danger of causing flicker or automatic controls to prevent it.

## System Automation and Network Planning

We played an important role in developing equipment to automatically locate faults and saw the next logical stage as demonstrators of the benefits of a fully automated network. The mid 1980's was a time when the electricity boards were beginning wide replacement programmes. We hoped that our DEBUT network design program would be taken up as an electricity supply industry standard.

# 2. Technologies 2016

## 2.1 ALVIN™ - Automatic Low Voltage Intelligent Networks

**The background**…

Energy Regulators continue to focus on increased availability and reliability of networks. Low-voltage network faults are a significant cause of Customer Interruptions (CI's) and Customer Minutes Lost (CML's) and can be the most troublesome faults to find and fix. To date, many Distribution Network Operators have already improved HV Network performance to such an extent that LV faults now make up a significant proportion of the CI's and CML's. It is estimated that LV networks cause 40% of CI's and 75% of CML's in urban areas.


Fuses are the traditional solution to low-voltage network protection. Their key limitations are that fuses require manual intervention to restore supplies and may not respond effectively or safely enough to every type of fault encountered.

**The need…**

Intermittent or Transient faults, which are increasingly common on ageing cable networks, often result in multiple fuse operations before a permanent fault occurs enabling the fault to be located and repaired. Inevitably, these types of fault lead to reduced supply reliability, operational costs, regulatory penalties and customer dissatisfaction.

A cost-effective, fit-and-forget auto reclose capability has traditionally only been available at higher voltages and deployment of these devices has contributed to HV Network performance improvements. Further analysis indicated that a significant reduction to network maintenance can be achieved if automation devices have multi-shot capabilities eliminating the need for any substation visit after post fault operations.

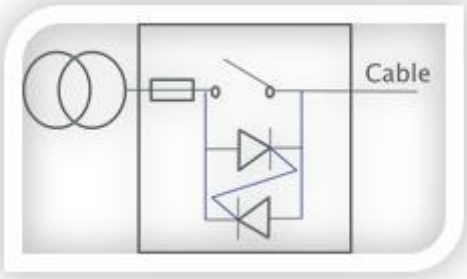
**What if**…

What if we could replicate the benefits of HV automation on LV networks by replacing traditional fuses and links with some kind of auto reclosing equipment which could stand alone or be part of a wider automated network?

The above requirements were translated into real hardware solutions that were developed during UK Power Networks' Smart Urban Low Voltage Networks (SULVN) Low Carbon Network Fund Tier 1 project and Flexible Urban Networks – LV (FUN-LV) Tier 2 project.

**The Solution**…

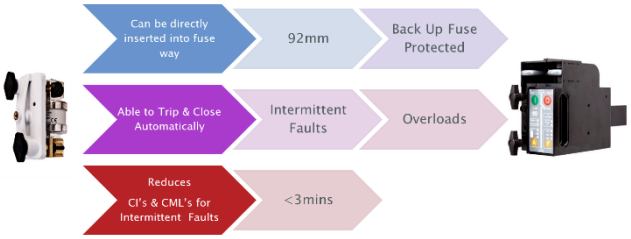
ALVIN Reclose™ was designed as a retrofit solution to replace BS88 fuses in Low Voltage feeder pillars and boards. It is built using compact sized circuit breakers, paralleled with semiconductor devices and in line with JPU fuses characteristics and rated to the required load current and providing arc free switching.





Alvin Reclose™ enables intelligent automation and fault restoration on low-voltage networks in a stand-alone, compact and cost-effective package. This device minimises CI's and CML's resulting from Intermittent or Transient LV faults. It is part of a family of complementary devices, designed for retrofit replacement of fuses and links which together can provide full automation, remote control and monitoring of LV networks.

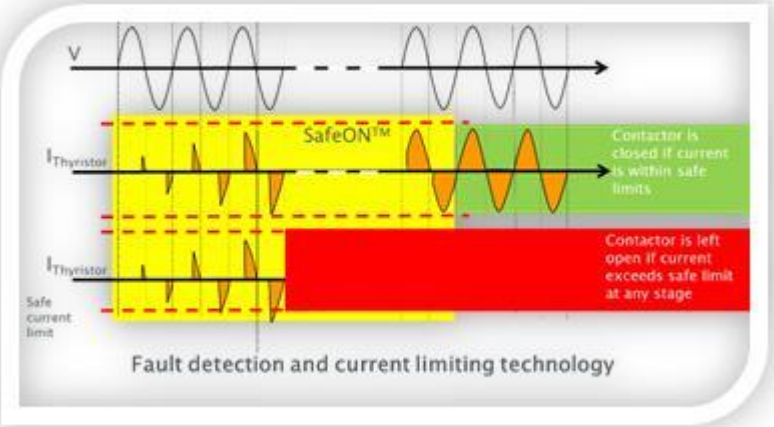
It has the following benefits:




**Automatic supply restoration:** for self-clearing faults, Alvin Reclose™ will automatically perform multiple circuit recloses, restoring supplies without manual intervention. For permanent faults, it behaves in the same way as existing fuse solutions.

**Saves time and effort:** Once fitted, no engineer intervention is required on-site as the device tests the network condition remotely, prior to automatically reclosing on the fault. Unlike other devices, this can be done multiple times without the need for engineer intervention.

**Improved safety:** Alvin Reclose's unique SafeON™ remote operation ensures power can be safely restored. It does this by using specially modulated power pulses through the power cable that warn customers or engineers in contact with a damaged cable that power will be restored imminently. The network is automatically tested for the presence of a permanent fault prior to full energisation, whilst retaining the assurance of back up protection via a conventional fuse.



## Deployment

### Automatic Restoration

Following an LV intermittent fault, the ruptured LV fuse is replaced by an Alvin Reclose™. If supplies are restored by Alvin Reclose™ then it is left in circuit. For subsequent intermittent faults, Alvin Reclose™ will automatically perform multiple circuit recloses, restoring supplies without manual intervention.

If the Alvin Reclose™ "locks out" - indicating a permanent fault, then the Alvin Reclose™ is removed, the fault is located and repaired as normal. Supplies are restored by fitting a standard fuse. The Alvin Reclose™ that has been removed is available for deployment on another fault.

### Automatic sectionalisation and restoration

Alvin Reclose™ and Alvin LinkSense™ are deployed on selected LV circuits. Alvin Reclose™ and Alvin LinkSense™ will automatically perform multiple circuit recloses for a Self-clearing fault, restoring supplies without manual intervention. For a permanent fault the Alvin Reclose™ and Alvin LinkSense™ work together to automatically isolate the faulted feeder section and restore supplies to the un-faulted sections. It also supports 11kV automation on networks where the LV is interconnected

### Remotely controlled reconfiguration of LV network

The connection of new devices on the LV network, including Low Carbon Technologies (LCT) such as Photovoltaic generators (PV), Electric Vehicles (EV) and Heat Pumps (HP), can result in different load and voltage profiles on the LV Network. A combination of Alvin Reclose™, Alvin LinkSense™, Alvin Portal™ and Link Controller™ devices can be used to:

- Monitor the network state (voltage, current, fault level, harmonic distortion etc.) and provide alerts
- Reconfigure the network to re-balance load and voltage
- It may also be possible (using algorithms which are not currently part of the Alvin product suite) to detect the presence of PV, EV and HP devices on the network

## 2.2 Condition-Based Risk Management (CBRM)

Ageing network infrastructure is not only driving up utility operating and maintenance costs but is also threatening to compromise network reliability. Financial constraints on capital investment and evolving regulatory drivers require a utility to make effective investment decisions for both day-to-day operations and longer-term asset investment programs.

EA Technology's Condition Based Risk Management (CBRM) is the world's most effective methodology for managing power assets and optimising investment decisions. It combines knowledge of the condition of assets, with the ability to calculate the financial risks of asset failures, to transform the way assets are managed.

CBRM is specifically designed to provide financial, operational and engineering leadership with a common understanding of the benefits/risks in any plan to replace ageing assets and justify investment proposals to stakeholders and regulators.

EA Technology's reference database is used to calibrate and validate a utilities available asset data, enabling the utility to prioritise capital spending to align with corporate strategies and make prudent investments when renewing ageing infrastructure.

### Early concepts

Towards the end of the last millennium, the concept of actively managing asset condition began to emerge. This was based on a recognition that simple, periodic maintenance may not be the most efficient way to keep an asset in serviceable condition; indeed, despite careful, periodic maintenance significant asset failures still occurred. It was established that measurements could be made of certain condition indicators (e.g. acid content in oil) and these would provide an accurate assessment of whether or not maintenance (or replacement) was required. Of course, there are many such indicators and the challenge was to combine these different indicators into a single, easily understandable measurement of asset "condition". Thus, the concept of the Health Index was born.

Pioneering work by Dr. David Hughes at EA Technology established that it was possible to derive a Health Index from complex condition information to give a single numerical value as a comparative indication of overall asset condition. In 2003, EA Technology presented a paper at the CIRED conference showing how a Health Index could be used to give an indication of the proximity to end of life for individual assets. This focus on "time to end of life", rather than "time to next maintenance" was an important distinction that led to some crucial developments…

### Predicting failure and consequences

It was quickly established that if Health Indices gave an indication of time to end of life, then they could also be used to predict the probability of an asset failure. Until this point, many methods had been tried to estimate the probability of failure of individual assets, but there had been no way to achieve this goal. A breakthrough came when it was realised that it was possible to combine the known *average* failure rate of a group of assets with the individual Health Indices to determine the individual probabilities of failure.

The next question was: if we can predict failure, can we predict what will happen when an asset does fail? If we can do that, we have all the components in place to evaluate *risk* – and control of risk is at the very heart of good asset management.

One of the earliest adopters of this philosophy was Electricity North West, who began work with EA Technology in 2003 to develop this idea into a practical system to plan and optimise asset replacement programmes. Other utilities also picked up on the idea and development work began in earnest.

The result was Condition-Based Risk Management, and a paper on this was presented at CIRED in 2005 by Dr. Hughes. For the first time, a structured framework was available to enable engineering knowledge and experience of network assets to be readily and transparently linked to corporate decision making.

## Optimum value

The possibility of expressing engineering decisions in terms of financial risk proved very attractive. Finally, it became possible to express complex, large-scale engineering programmes in simple, financial terms: essential not just for senior management, but also for utility regulators, investors and – ultimately – utility customers who usually end up financing such activities.

The process of expressing engineering risk in financial terms was refined over the next few years, resulting in papers by Dr. Hughes, Tracy Pears and Paul Barnfather at the next two CIRED conferenced.

By 2009, the potential to optimise asset risk had been clearly demonstrated: it was now possible to project asset risk forecasts many years into the future and offset this against the likely cost of replacement. The result was that CBRM was now not simply able to determine asset replacement, but to show that the proposed replacement programme represented the best possible value out of all replacement options.

This powerful idea gained rapid acceptance in utilities across the world, resulting in large CBRM deployments, especially in the UK and Australia. As an illustration of the power of CBRM, in 2009 the independent consultants appointed to review the Energex (Australia) investment programme concluded that CBRM that 20% fewer replacements would be necessary to maintain a safe system - saving $200m from a planned $1bn replacement programme.

## Business as usual

The potential to make significant savings on capital programmes caught the attention of investors and regulators worldwide, resulting in a rapid scaling-up of CBRM deployments from simple desktop applications to company-wide systems. By 2012, the enterprise-grade CBRM 2.0™ product had become the de-facto standard for effective management of risk-based capital programmes, used by over 30 utilities around the world.

After encouraging UK utilities to adopt such techniques during DPCR5 (2010-2015), the UK regulator Ofgem took a major step for the RIIO-ED1 regulatory period (2016-2023): A “common methodology” was enforced on all UK DNOs, requiring regulatory targets and programme outputs to be reported using a single, unified methodology. The resulting Common Network Asset Indices Methodology (CNAIM) - developed jointly by EA Technology with the UK DNOs and based on CBRM techniques - covers 25 electrical assets classes including switchgear, transformers, overhead lines and cables. For the first time, progress towards regulatory objectives can be closely monitored for the whole of the UK and the consistency of reporting enables benchmarking and ranking of DNOs. Through these mechanisms, outperformance can be rewarded (and underperformance penalised), shaping DNO behaviour and delivering better value to customers.

## Beyond risk

Asset management is defined as the “co-ordinated activity of an organization to realize value from assets”. Crucially, the decision-making processes of effective asset management are risk-based, but the focus should always be on *delivering value from assets*. The RIIO regulatory framework confirms this view, by rewarding as *“justified changes in risk across the network”*. Where the change in risk is not known or understood, any apparent outperformance is excluded from the reward. This means that the calculation of asset risk, and the effect of different intervention strategies on that risk must form the basis of any plan.

The result is that in order to outperform under RIIO, investment plans must be risk-based, taking a network-level view and using a documented methodology that preserves the reasoning and rationale for each decision. For a DNO with responsibility for managing hundreds of thousands of assets and supplying millions of customers, this could represent a formidable challenge.

Thankfully, CBRM techniques again provide the answer. EA Technology's new Asset Investment Management (AIM) platform integrated the CBRM methodology into a scalable suite of products that can systematically analyse asset health, criticality and risk, while enabling maximum value to be obtained from assets and their associated investment plans through regulatory reporting regimes such as CNAIM to report on the outcomes. The flexibility of the AIM platform enables CBRM techniques to apply to a whole new world beyond mere risk management and embraces the concept of generating value all assets.

In conclusion, CBRM is a pioneering product that has established the foundations risk-based asset investment management and in the future will enable utilities to extract maximum value from every asset under their stewardship - the very definition of excellence in asset management. This will both maximise revenue for DNOs while reducing costs to customers. We believe this is a goal worth striving for.

## 2.3 PD Detection at EA Technology – A Very Potted History

Partial Discharge (PD) is the localised dielectric breakdown of a small portion of electrical insulation between two High Voltage (HV) conductors. If PD occurs inside HV equipment it will degrade the insulation and, in the absence of any remedial action, it will eventually lead to catastrophic failure in the form of a destructive flashover. Hence it is important to be able to detect the PD before it causes any serious damage in order to maintain network reliability and worker safety. Over the last 30 years EA Technology has developed a range of instruments to detect PD within energised HV plant and switchgear, much of it using a technique known as Transient Earth Voltage detection, or TEV for short.

Dr John Reeves was the Father of TEV at EA Technology, responsible for the pioneering research in the late seventies/early eighties that underpins the wide range of instrument EA Technology sells throughout the world today. He demonstrated that it was possible to detect internal PD non-intrusively by measuring minute transient voltages using a capacitive sensing probe placed in contact with the outer-surface of energised HV metal-clad switch gear.

The first TEV prototype was produced in 1984 and had a single probe. This proved effective for detecting PD, but it was soon discovered that the highest signal magnitude did not always correspond to the position of the PD source making physical location difficult. The solution was to introduce a second probe and then, by observing which probe saw the TEV signal first, it was possible to determine its direction of travel and hence pinpoint where it was coming from. In 1990, the first commercial dual probe instrument the PD Locator PDL1 was launched, marking the start of the Instruments Business at EA Technology.

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|  |  |  |
| Early ECRC prototype TEV circa 1979 | Prototype TEV | Prototype TEV |
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| The young Dr Reeves testing the first single probe TEV 1984. | Prototype Double Probe TEV 1985 | The young Crabbers having a go too with the Dual Probe TEV 1985 |

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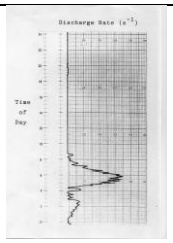
|  |  |  |
| Dual probe PD Locator PDL1 built by EATL in 1990. | Prototype PD Monitor | Trace showing activity in early hours of the morning |

In the 1980's experiments in continuous PD monitoring (as opposed to spot measurements) were performed using a modified prototype with a paper chart recorder attached to it. This early PD Monitor lead to the important discovery that some plant only discharged at a certain time of day, and that PD was heavily influenced by environmental conditions, such as temperature and humidity. The knowledge gained was used to develop EA Technology's first PD Monitor, the PDM03, launched in 1993 and capable of continuously monitoring multiple sensors mounted throughout the substation.

| | |
|---|---|
|  |  |
| Circa 1992 the Electronics Development Team looked something like this. | And 20 years later in 2012. |

| | | |
|---|---|---|
|  |  |  |
| Eoin setting up PDM03 | Pete coding | PDM03 |

Attention then focused on developing a range of small hand-held instruments for performing spot measurements. The MiniTEV and MicroTEV were subsequently followed by the UltraTEV Detector, launched in 2003. This was the first instrument to combine TEV and Ultrasonic capability so that it could detect both internal discharge and surface discharge. The instrument proved popular and

went on to win the Queen's Award for Enterprise Innovation in 2007. The more sophisticated UtraTEV Plus was launched in 2007 and included a directional parabolic microphone; a key enhancement that allowed the operator to locate surface discharge sources on live equipment safely from a distance using ultrasound, winning another Queen's Award in 2011 for Continued Innovation. To-date, over 8000 UltraTEV Detectors and UltraTEV Pluses have been sold in more than 40 countries.

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|---|---|---|
|  |  |  |
| MiniTEV2 2001 | UltraTEV Detector 2003 | UltraTEV Plus 2007 |

The PD Development Team continued to expand and more complex whole-substation monitoring systems were developed with the release of the UltraTEV Alarm in 2007, UltraTEV Monitor in 2009 and the PD Monitor GIS in 2012. The latter systems incorporated the innovative UltraBus that allowed discrete sensor nodes networked together to achieve nano-second synchronisation enabling discharge mapping across equipment panels.

| | | |
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|  |  |  |
| UltraTEV Alarm 2006 | UltraTEV Monitor 2009 | PDGIS 2010 |

EA Technology's first instrument for measuring PD on underground cables, the CableData Collector, was released in 2010. Using Radio Frequency Current Transformer (RFCT) sensors clipped onto the cable earth strap, this small portable instrument can detect and locate PD on underground cables from the terminations in the substation whilst the cable remains energised and in service. The same technology has more recently been deployed the CableData Monitor; a system intended for permanent installation, for monitoring the health of HV cables and HV cable joints over time.

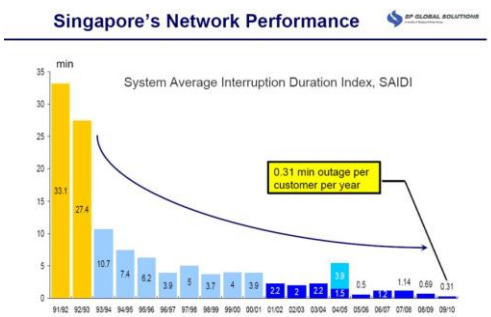
| | | |
|---|---|---|
|  |  |  |
| 2010 CableData Collector | 2014 CableData Monitor | CableData Monitor Node |

Responding to a need for safely detecting discharge on live overhead lines and outdoor HV switch compounds, the PD Hawk was developed and launched in 2012. It employs a novel directional flat antenna (that is safe to use in the live HV compound) to detect radio frequency emissions from the defective equipment. Recently, the PD Hawk has also been used to successfully detect PD inside certain types of cable joint too.

| | |
|---|---|
|  |  |
| 2012 PD Hawk | UltraTEVPlus[2] |

As for the benefits, there are many examples of where EA Technology's PD products and services have saved clients significant sums of money. For instance, UAE Utility ADGAS estimated they had averted over $15m loss due to potential switchgear failure as a result of investing $100k in PD surveys and instruments. Singapore Power estimate they have prevented 571 failures over a ten year period enabling them to reduce their customer minutes lost from over 30 minutes down to 0.31 minutes/customer/year.

Marking its 50th Anniversary year, EA Technology is launching its most sophisticated hand-held PD instrument yet – the UltraTEV Plus [2]. This is a significant and exciting upgrade on its highly successful predecessor, the UltraTEV Plus. It can be used on both switchgear and cables, and provides a host of diagnostic tools that make it even easier for the operator to distinguish genuine PD from other sources of electrical interference. Measurements are stored internally and can easily be downloaded or synchronised with corporate asset management systems using WiFi, USB or SD memory cards. This increases the accuracy and productivity of substation inspections as well as allowing trending over time to detect any changes in equipment health. With a range of new add-ons already in the pipeline, who knows what the next 50 years will bring?



## 2.4 Lightning Location System by Peter Brookman

The EA Technology Lightning Location System has come a long way since its instigation in the late 1970's.

The first lightning location system in the UK was built when EA Technology was known as the Electricity Council Research Centre (ECRC). It consisted of four outstations, situated around England and Wales with communication to the outstations via a private telephone wire. Data was processed at a central control centre at Capenhurst, with the results printed out on a Teletype machine, with validated lightning strikes confirmed with paper punched cards, similar to that shown in Figure 1.

**Figure 1 Typical Teletype machine used for the first Lightning Location System**

Although the early system was successful in detecting lightning strikes, the technology was not advanced enough to allow true practical benefits from the system. As a result, the original system was discontinued.

Once technology matched the aspirations of the system creators, a new system was built in the 1980's. The new system began with three outstations, based in Cheshire, East Anglia and Devon, which communicated with a UNIX based central control centre at Capenhurst.

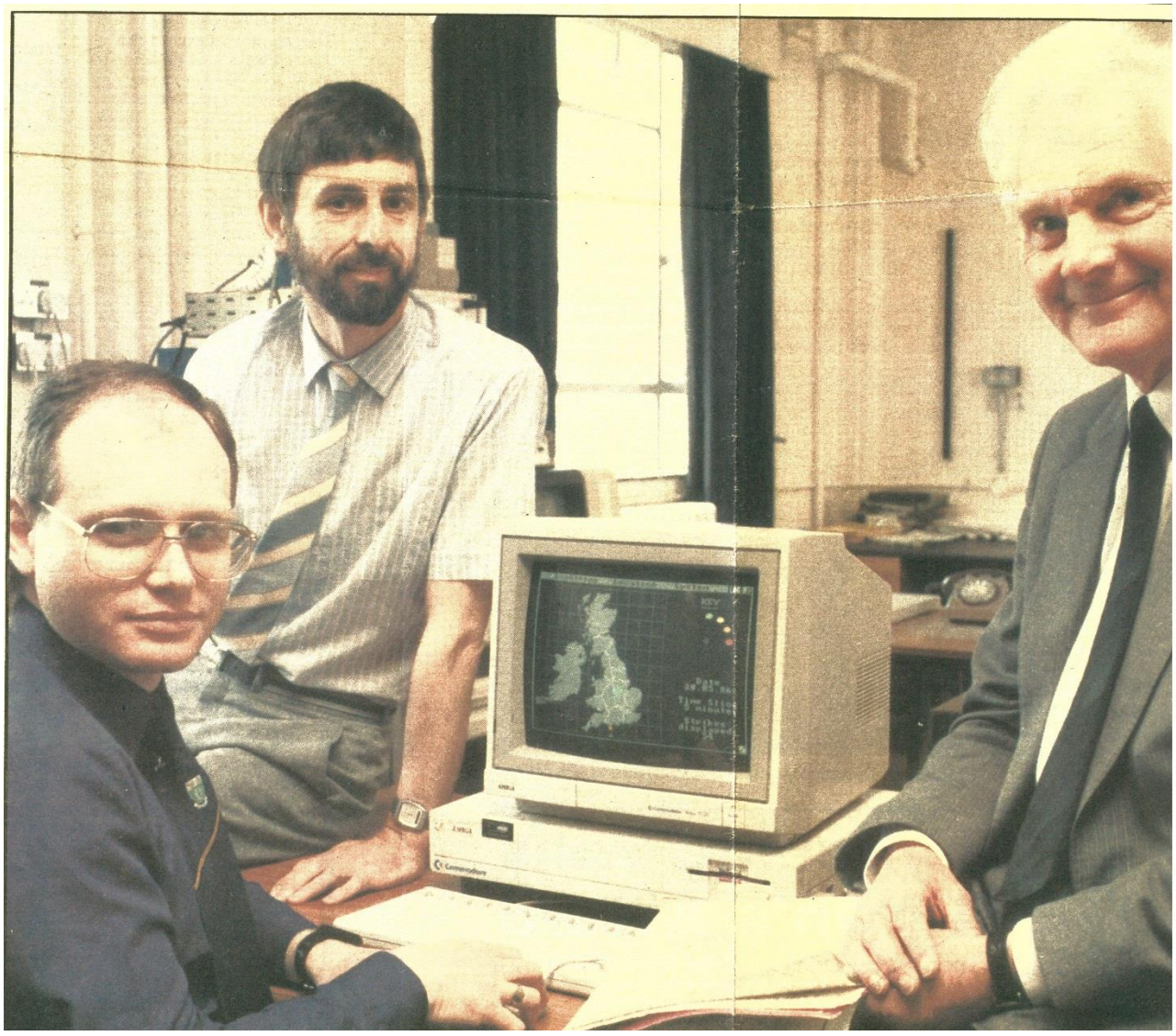


**Figure 2 The EA technology Lightning Location System with Alan Moore, Graham Bulmer and Bill Baker (insert date)**

Following a successful analysis of the system in 1989, two more outstations were added in the north of England and Scotland, until finally in the early 1990's a sixth outstation was added in Ireland.

The current lightning location system still uses the six antenna stations around the UK to receive the radio waves emitted by lightning strikes, with the information coming back to the upgraded central processing hub at EA Technology's Capenhurst site. There, a computer system combines the information received from the different stations to produce a strike fix with the time of the strike, geographical location, polarity of strike and estimated peak current.

Customers, mainly in the electricity distribution sector, use this information to control risk for personnel working on elevated structures at risk of lightning strikes, and in managing the damage caused by lightning strikes to their assets. With the display screen now having more detailed information, visibility of incoming storms is easier to see and act upon.

The 2016 Lightning Location system has come a long way from its instigation. Not only has the background computing power increased dramatically, it now looks significantly different from when the first display screen was created.

Users now have the availability to zoom into the UK map to allow for accurate location confirmation.

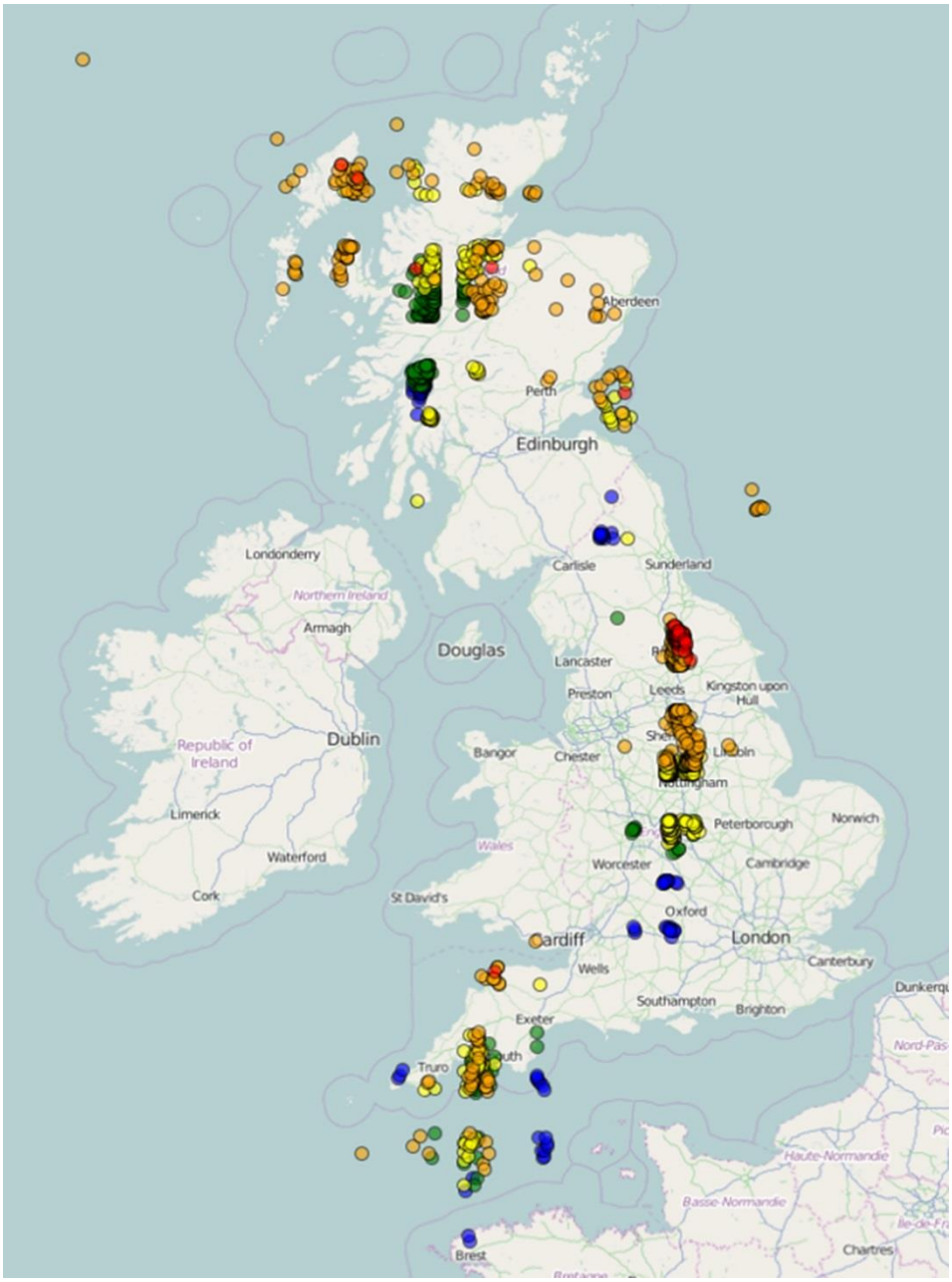



**Figure 3 The 2016 EA Technology Lightning Location System**

The new front screen also has the ability to include live weather data that can further advance the interpretation and prediction of locations of possible lighting strikes.

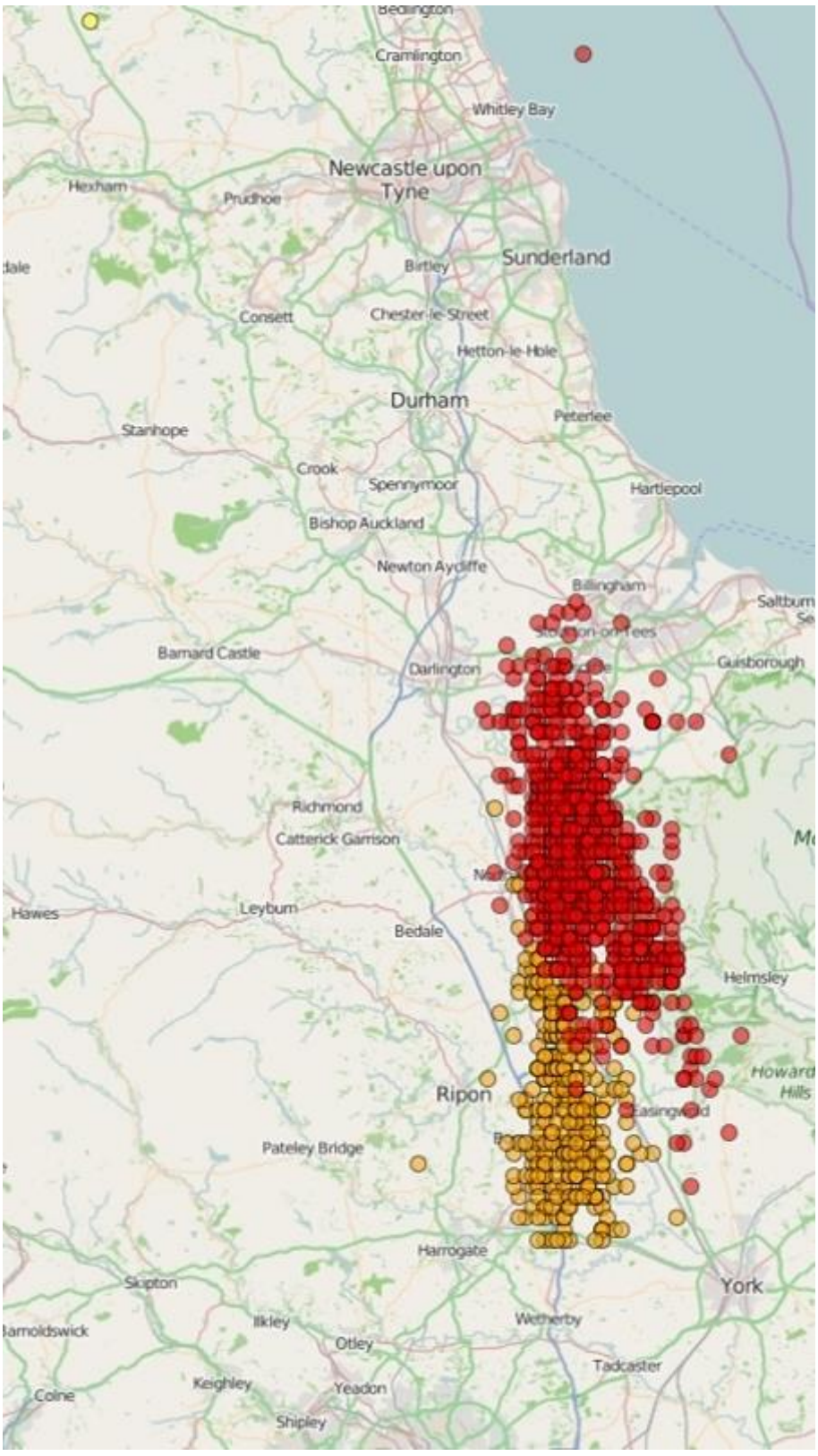



**Figure 4 The 2016 EA Technology Lightning Location System**

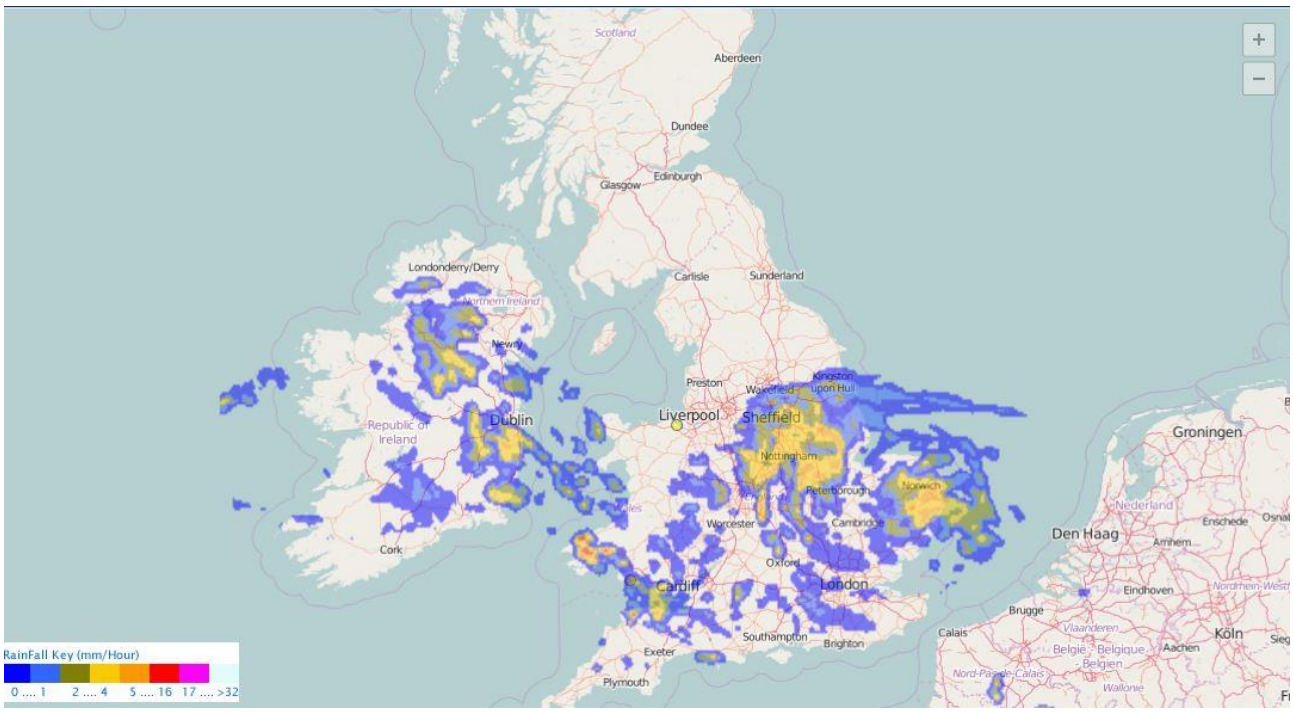



**Figure 5 Live rainfall data on the 2016 Lightning Location System**

This highly successful system is not only used by British Standards and Electricity Companies; it is now being opened out to general industry with even the possibility of it being utilised by outdoor festivals.

## 2.5 Oil Diagnostics by Anne McIntosh

### A National Industry Crisis

In the late 1990's incidents of seriously degraded insulation oil in switchgear leading to catastrophic failures were reported by several of the UK DNOs (then known as RECs). The issue soon escalated into a crisis for the industry, with the majority of the DNOs and a wide range of manufacturer's switchgear affected. Due to the significant safety concerns for personnel wide scale operational bans involving 10,000s of units were put in place which seriously affected the operation and reliability of the network. In true British spirit all of the companies worked together, sharing their knowledge and experiences largely though EA Technology's Plant Engineer's Forum (PEF). It was identified that the common factor to the failures was the source of the oil, which was found to have been manufactured by Carless at their Kilpatrick plant during 1987 to 1991. Work undertaken by EA Technology determined a technique to identify the suspect oil. However it was apparent due to the scale of the problem a non-invasive method to determine the condition of the effected switchgear was required. Through the Strategic Technology Programme (STP) supported by the DNOs EA Technology devised a headspace gas testing method which determined the condition of the units and the level of degradation, enabling the DNOs to effectively manage the situation.

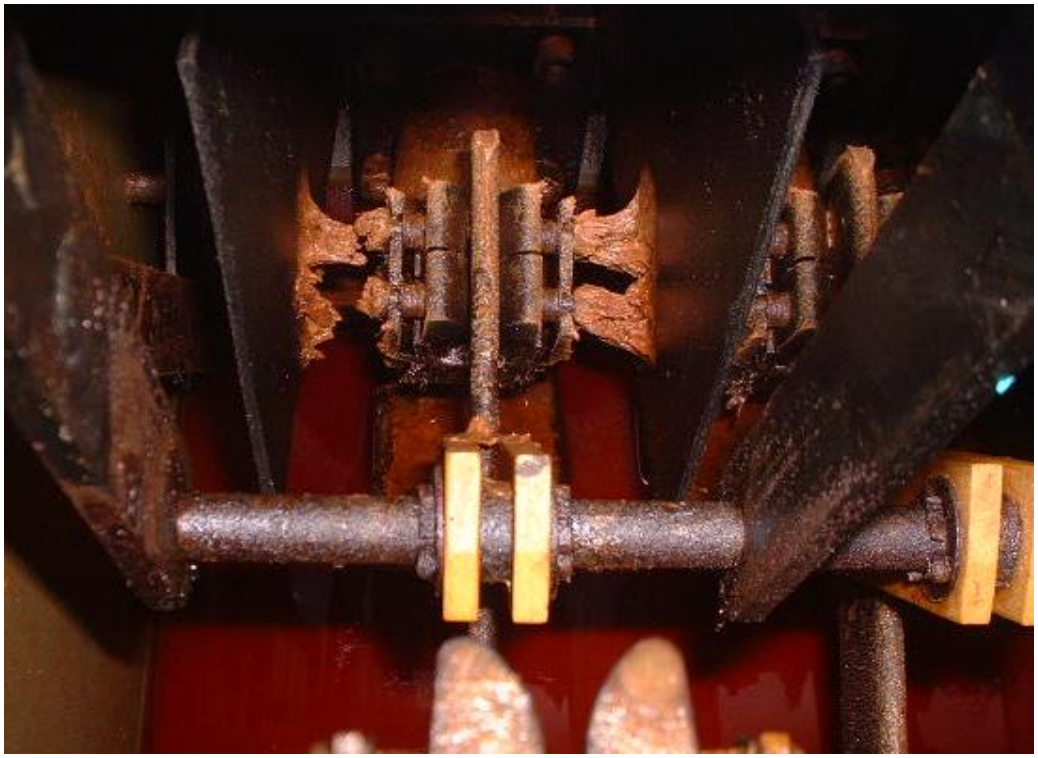


Figure 1. Severely sludged oil filled switchgear

(photos H/LAM/Oil/Sludge/photos)

### From Research to Operational Efficiency

The sludging oil issue brought the management of switchgear to the forefront of DNO's activity. Through the STP, collaborative research was undertaken, to gain a better understanding of the materials and degradation associated with oil filled switchgear. The numerous projects undertaken cumulated in the simple premise that the oil is the critical factor in determining the optimum switchgear maintenance interval and there was scope to increase maintenance intervals without compromising the reliability or safety of the switchgear; at the same time DNOs were striving for operational efficiency. Consequently the push was to move from time based maintenance to condition based maintenance for oil filled switchgear and two approaches were adopted by the DNOs.

### *Statistical Sampling*

Development of the learning from the STP research resulted in EA Technology offering a service based on a statistical sampling approach to determine the optimum maintenance interval for a 'family' of switchgear based on their condition. This resulted in significantly increasing the maintenance intervals, saving £100,000s pounds per annum for the companies adopting the approach without detrimentally effecting the switchgear reliability.

### *Live tank Oil Sampling (LTOS)*

Northern PowerGrid (then Northern Electric) pioneered the development of Live Tank Oil Sampling (LTOS) with support from EA Technology and in 2003 EA Technology launched its service. The method enables an oil sample to be taken with minimum disruption to the network. This service optimised the maintenance interval for *individual* units and resulted in massive savings, again without compromising the reliability of the network.

Figure 2. Live Tank Oil Sampling (swop with LTOS sampling image from the sales brochure)

**Example: 80% Cost Saving**

Moving to LTOS from time-based maintenance has reduced the cost of maintaining 500 units by more than 80% per annum for one of our clients. The safety and reliability of their network has also improved, thanks to lower switching requirements and rates of failure.

## Extracting Asset Management Value

The new millennium saw a shift in focus from age to using the condition of assets as a means of defining the need for asset replacement. The consultancy and services provided by EA Technology in this area was entitled Condition Based Risk Management (CBRM). The essence of CBRM is to use all the available knowledge, experience and information relating to assets to define the present condition and then estimate future performance on the basis of ongoing degradation. Part of this process is to generate a Health Index for each asset from which a probability of failure and end of life can be calculated.

In 2003 EA Technology developed the Health Index approach into a service for transformers and the oil analysis was crucial to formulating this Health Index. The service has led to improvements in the management of oil filled transformers for our customers and extracting added value from oil analysis.

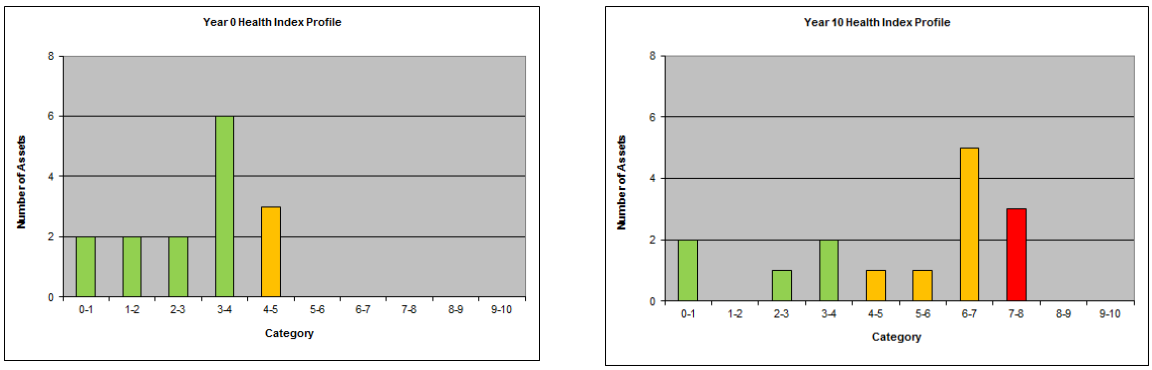



Figure 3. Health Index adopted for oil filled transformers

## Launch of Oil Diagnostics

Oil Diagnostics by EA Technology

Building on our long heritage and oil analysis experience, EA Technology launched 'Oil Diagnostics' in 2015. The facility is equipped with state of the art instruments to provide accurate and reliable results within the turnaround time required by our customers. In addition, our understanding of the design, operation, degradation and failure mechanisms associated with oil filled assets, enables us to offer our clients an unrivalled service that provides the recommendations they need to effectively manage their assets.

Figure 4. Oil Diagnostics laboratory

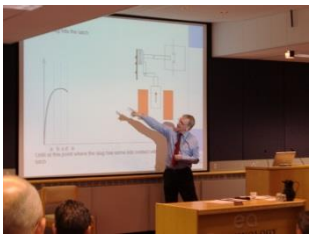
## 2.6 Education & Training by Steve McIntosh

EA Technology has always had a history of education and training. In the early years this was directly related to its research and development function, particularly when applying innovative technology to support the electricity sector.



This practice of disseminating information continued for many years on key projects and commissions, however, it was not until the mid-1990's that a specific Training & Events business was introduced. This early initiative focused entirely on the development of short duration courses and conferences for Distribution Network Operators and supporting industry.


Further courses were established, particularly in emerging or new areas of significance to the electricity sector. Market potential evolved and courses continued to be developed and delivered, using EA Technology's respected industry experience. Courses were also complemented by other manufacturing and industry specialists ensuring delegates received the best possible experience.


Today, EA Technology's training business is called the Power Skills Centre. This is an outcome based, competence driven business that works collaboratively with key clients and industry to deliver the very best education and training. From industry leading short courses, managed graduate programmes, technical staff development or industry specific qualifications, the Power Skills Centre continues to maintain and improve upon the standards set through our 50 year heritage.

## 2.7 Electric Vehicles – Spotting trends, riding waves - by Dave A Roberts

**The electrification of transport is becoming a global phenomena, with rapid acceleration expected in the coming decade. EA Technology has carved itself a niche in both understanding its impact and solving any problems for electricity distribution networks. The wave is growing, we are on it, and picking up more and more speed.**

**In the beginning** …

It is interesting to reflect on how increasingly vital electricity has become for our everyday lives, over the lifetime of our company. From the early days where it was used solely for lighting, the last 50 years have seen rapid increases with electrical power used, from heating/cooling, to cooking, to powering the vast array of gadgets we now have in our homes and offices. We are standing on the brink of the next wave - electric mobility.

Since 1966, the electrification of transport has had several false dawns. Trials undertaken in the early days struggled to reach a market beyond highly specific applications such as the local milkman, where, presumably, silent delivery was seen as a USP. But's let's be frank, they've never been mainstream.

**Doing it before it was cool** …

EA Technology has been supporting the development of 'electric-miles' for many decades. From trials of electric buses in the 1990s to the early wave of electric cars, we've been keen to support the sector; traditionally focussed on the technological challenges associated with the batteries and technology on board the vehicles themselves.


**Spotting trends** …

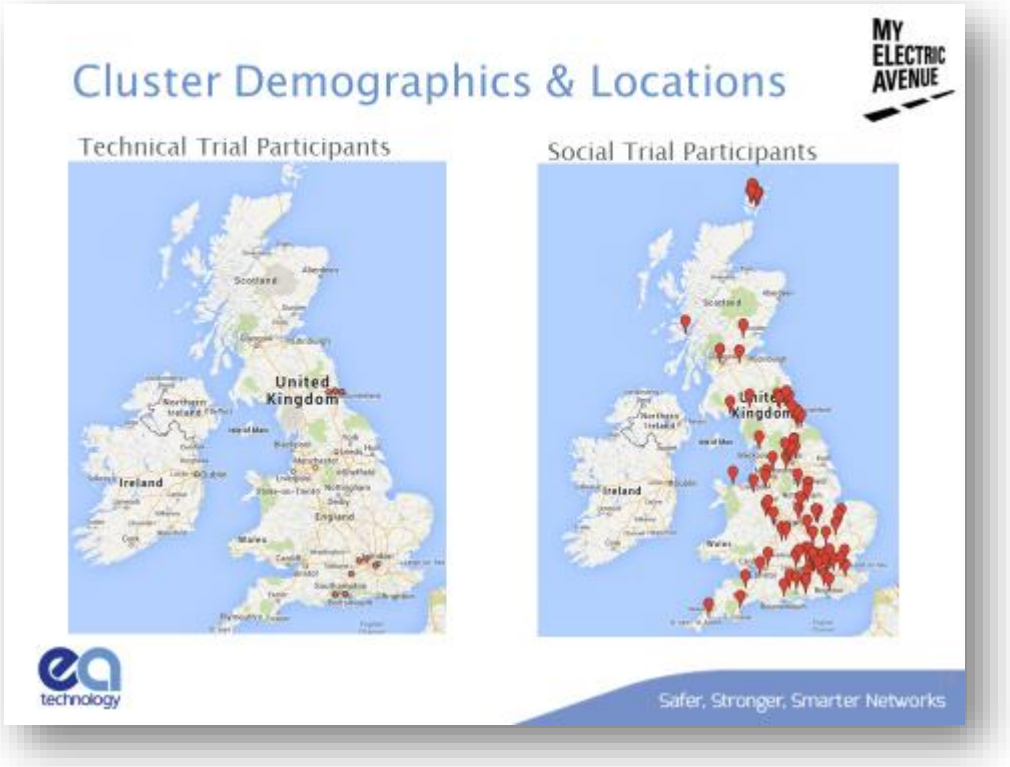
Fast forward to 2012. Studies undertaken by EA Technology, working with UK Government and the network companies showed the potentially significant rise in electric and plug in hybrid cars for the coming years. On the back of this, we created one of the largest electric vehicle projects in the world – the three year / £10m, iconic, award winning, My Electric Avenue.

MY ELECTRIC AVENUE

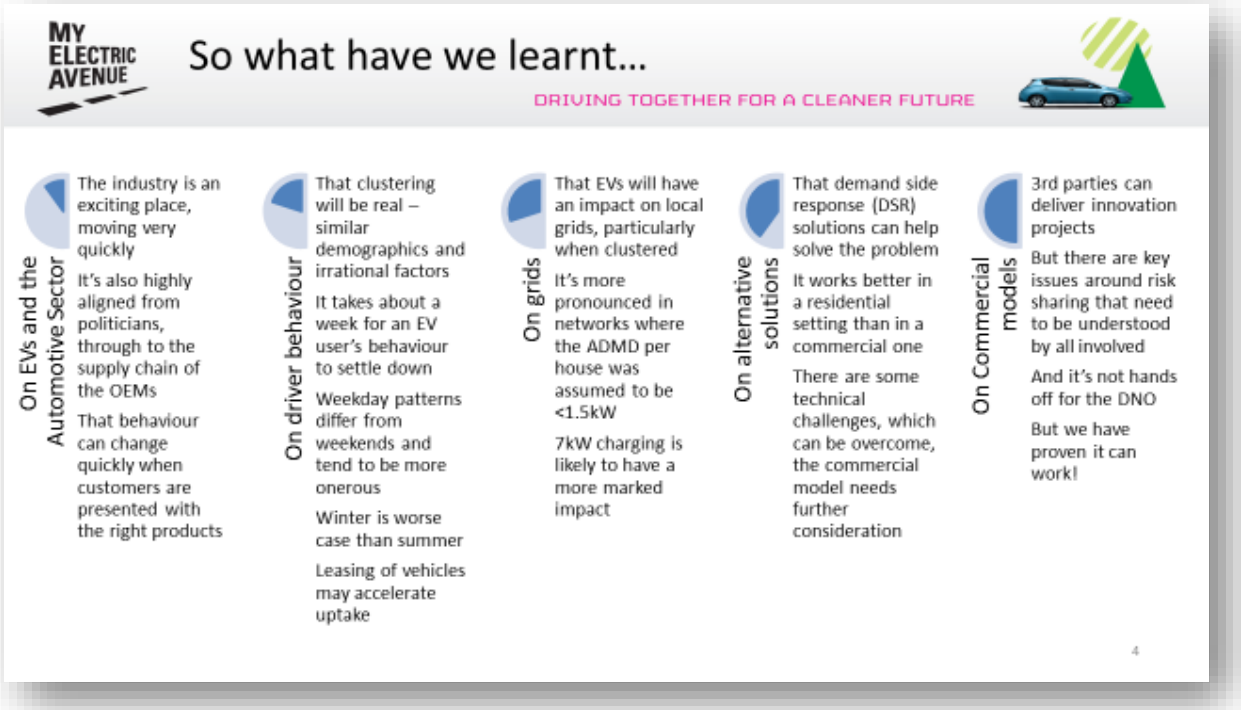
So why did we bother …

..The project shamelessly focussed on the power system that would be needed to support electric mobility. Not whether there is enough generation to address a massive uptake, but the very local issue of 'what happens when loads of people living in the same street get an EV, come home (at roughly the same time), plug in their cars, and go inside to make dinner'. Could the local grid accommodate this, and if not, what options are available to the DNO? We played into our strengths of focussing on the power networks, delivering innovation projects, and amalgamating a technology. We created Esprit.

The project wasn't without event – epic recruitment challenges, contractual risks and the vagaries of real customers/Ofgem, resulted in EA Technology bank-rolling the project for a short, but nerve-racking period. But we lived to tell the tale.




What did we learn (www.myelectricavenue.info)




Timing for My Electric Avenue was, let's be honest, perfect!

**Riding waves** …

But sustainable business isn't about one-offs, it about replicability. Riding the waves for as long as you can, before kicking out just before they hit the shore… then catching the next wave.

So is there a trend? In my opinion, there are several reasons to suggest the EV waves are real, reasons why we should take notice:

- Firstly, the decarbonisation agenda – its widely accepted that our 2050 carbon targets cannot be met if we still rely on petrol and diesel to get from A to B. This makes even more sense as we shift from fossil fuels to power our generators to wind, solar, water and nuclear power. The concept is supported by a UK Government target for all new sales of cars and vans being Ultra Low Emission by 2040. That's only 24 years away – less than half the time we have been in operation.
- Secondly, air quality – this is becoming an increasing issue particularly for our cities, and has been curiously exacerbated by the rise of the diesel car. Paris received the dubious honour of having the world's worst air quality for several weeks in in 2015, with France's obsession with diesel engines being a dominant factor. The Volkswagen emissions scandal brought this into sharper relief. Poor air quality kills – it's not the sort of thing that any politician wants on their hands.
- Thirdly, the vehicle manufacturers themselves and us as customers. The companies behind the cars we drive play to a global market. They rarely create a product that works for only one country as the costs of doing so, can't be supported by one market alone. Trends are easy to spot when it's more than just one organisation doing it. As I write this you can buy one of 39 makes / models of EV/PHEV with another five or six coming out by the end of 2016. In context, there were around five makes/models around when we conceived My Electric Avenue in 2012! Now that's acceleration. The purchasing of an EV is starting to become a consumer choice – the waves have never been stronger.

But a wave is no good without the right tool to ride it. In our activity, we've done well so far – we've played to our strength, focussing on the power network, rather than the car, and this has allowed us to carve out a clear standing. We are now looking to capitalise on the unique position we find ourselves in:

- **Galvanize the position / collaborate**: EV Network Group: this Group, co-chaired by the Low Carbon Vehicle Partnership (LowCVP) and EA Technology, will facilitate dialogue between the low carbon automotive and utilities sectors, acting as the conduit for information flow between those sectors and UK Government. The Group will drive forward solutions that will allow electric vehicles to work in harmony with the GB electricity distribution network. It will act as a focal point to promote technological and infrastructural needs, in order to maximise the number of electric miles by 2030 in the most cost efficient way. The EV Network Group will power our electric future.
- **New projects**: Two pivotal projects to underline our role:
    - Smart EV: hosted by SSEPD and delivered by EA Technology, the aim of this 18 month project (a follow-on to My Electric Avenue) is to achieve consensus on the communication / system protocol that can be used to facilitate the roll out of controlled plug-in vehicle (PIV) charging. In doing so, it will enable significantly larger numbers of PIV charging on today's local electricity distribution networks, with sizeable reduction in investment costs and customer bills/disruption. For more detail, the project registration document is located here.
    - CarConnect: hosted by Western Power Distribution, and delivered by EA Technology, is set to be the largest EV project in the world, working with up to 700 EV trial participants. This £5.3m project will give Western Power Distribution and all other GB Distribution Network Operators (DNOs) an assessment tool and product-based solution that will enable DNOs to plan for and manage Plug in Vehicles and vehicle to grid services on their distribution networks. The project will run for three and a half years. For more detail, the project registration document is located here.

- Developing technology when the signals are right: on the back of SmartEV, invest in our technology once it is clear how it can be rolled out.

The automotive space is an exciting one to be in, standing on the cusp of a genuine revolution. In my opinion, power networks will never be more important. If we get this right, it will act as a springboard to our next 50 years!

## 2.8 Cable Sniffer by Dawn O'Brien

Work began on the CableSniffer™ in September 1996. Before this time EA Technology had carried out some work using gas sensors in the area of online condition assessment for oil-filled electrical equipment, but issues with calibration and drift of the available sensors meant that the application was not viable.

The work was carried out as part of the Postgraduate Training Partnership and Sponsored by Module 3 of the Strategic Technology Programme. It is not known who was responsible for the original idea for the project, but over the years several UK Distribution Network Engineers and EA Technology Sales staff have claimed this accolade. What was known was that cable engineers have long been able to tell when they were digging on a fault due to the characteristic smell, and it has been known for sniffer dogs to detect cable faults from above the ground.

The project was completed in four main stages:

1. Laboratory and field testing to identify the gases produced by cable faults.

Gases were collected from faults created in the laboratory and from cable faults in the field and analysed to identify common gases from cable materials.

2. Laboratory testing of sensors capable of detecting the identified gases.

Possible sensors were identified for detection of the common gases and laboratory testing was carried out to determine the best sensor combination.

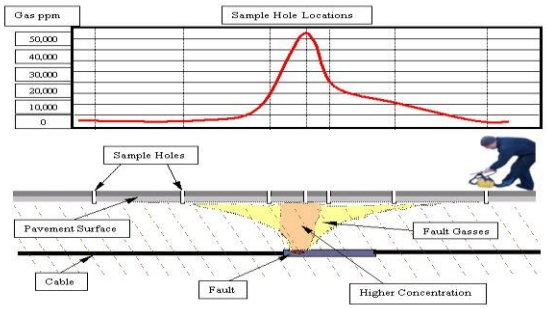
3. Development and field testing of prototype instrument.

The identified sensors were built into a field prototype instrument which allowed the concept to be successfully proven in the field.

4. Development and testing of commercial instrument

It took some time to identify sensors of appropriate longevity for a commercial instrument and to develop the instrument, but the CableSniffer™ was launched in 2001.

It has since gone on to be used by all of the UK Distribution Network Operators to allow them to locate and repair High Voltage cable faults more rapidly and at a reduced cost compared to historical methods.



## 2.9 Helicopter Services by Graham Earp

Strangely enough the Helicopter Overhead Line (OHL) Inspection Service, as we know it today, owes its origins to a project that set out to examine the potential for robotic applications within the electricity supply industry over 20 years ago! A review of the state-of-the-art in 1994 identified over 50 potential applications in the area of inspection and maintenance. These were ranked in order of priority by the UK Electricity Distribution Network Operators (DNOs) and the highest ranked was for an Unmanned Aerial Vehicle (UAV) for OHL inspection.

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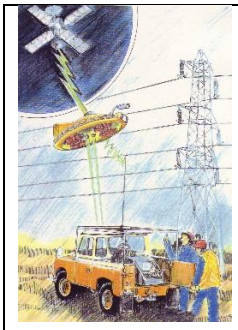
|  |  |  |
| Original Artists Impression to Illustrate Concept | SPRITE Plan symmetric helicopter UAV | SPRITE Deployment |

Over the next few years funding was secured through EA Technology's Core Research Programme, including an EPSRC Industrial Research Fellowship with the University of Wales, Bangor, to perform a technical feasibility study on behalf of the UK DNOs. This considered a wide range of issues including functional requirements, navigation, image stability, flight planning, GPS (very new in those days), communications, and even identified a suitable UAV – a plan-symmetric helicopter called SPRITE. The study showed that technically it was feasible. However, in order for the business case to stack up, there was a need for the UAV to be able to fly beyond line ofsight; unfortunately aviation authorities would not permit this in civilian airspace.

So in 1997, attention turned to trying to use the learning from the feasibility study to enhance aerial OHL inspection from manned helicopters under a new Strategic Technology Programme (STP) project. This included evaluating a state-of-the-art gyro-stabilised video camera platform mounted on the helicopter and mainly focused on inspecting wood pole OHLs. However, the trials revealed that it was extremely difficult for the camera operator to keep the camera trained on the OHL making the whole process too slow to be commercially viable. For the next few years research continued to try and combine GPS and image recognition techniques to develop an automatic power line camera tracking system but unfortunately this failed to attract the backing of a stabilised camera platform manufacturer to realise a commercial product.

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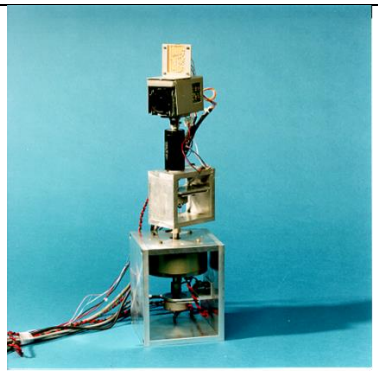
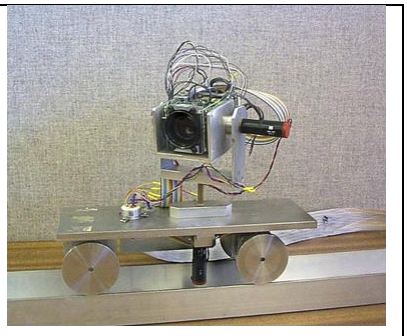
|  |  |  |

| | | |
|---|---|---|
| First use of Stabilised Camera | Image Stabilisation Test Rig | Camera Tracking Test Rig |

The break though came in 2003 with the advent of high-resolution digital SLR cameras and high-power stabilised telephoto lenses that allowed a camera operator to capture very detailed still images through the open door on the helicopter whilst looking directly through the lens. This gave superior results to video and alleviated the need to steer the camera's sight line remotely from a console inside the cockpit. Another important decision was to concentrate on inspecting steel towers rather than wood poles. The helicopter method was cheaper, faster and safer than the conventional climbing inspection and produced more reliable results. It also avoided the need for any power outages or switching. The icing on the cake was the decision to marry it up with EA Technology's CBRM process. The helicopter inspection was tailored to capture a virtually perfect data set to drive the software model, thereby maximising accuracy. The result was a complete turnkey service to help network operators manage their OHL assets more effectively and formulate their investment strategies based on real condition information.

| | | |
|---|---|---|
|  |  |  |
| Plastic Box | Metal Crate | Heli Crate |
|  |  |  |
| Defect Recorder | ESQC Recorder | Heli-Lite |

**Figure: Evolution of the on-board equipment**

The first major contract for inspecting 420 steel towers was awarded in 2004 by CE Electric. Since then, EA Technology has developed a wide range of on-board equipment as well as methods and techniques to process the captured information to obtain consistent results more efficiently. Well over 40,000 towers have now been successfully inspected within the UK using this technique, as well as a number of main-line railway routes. But the story may not be over yet. In recent years, with the advent of cheap lightweight UAVs, miniaturised GPS navigation, and organisations seeking to revise the air traffic regulations, we may still see the technology go full circle back to the original UAV concept in the not too distant future.

Rogues Gallery!

| | | |
|---|---|---|
|  |  |  |
| Founder Members on the First CE Electric Job | It was cold! | Condition Assessment |
|  |  |  |
| It was warmer in Kent – just! | Top Gun | Experiments with lasers |
|  |  |  |
| Ralph Doing Selfies | Nick Expecting Heavy Rain | Would you fly with this pilot? |

# 3. Future Direction

## 3.1 Distributed Intelligence

At a time when mobile devices are in the hands of billions of people around the world, the opportunity to migrate consumer-led sensing and communications technologies into the energy generation, distribution and consumption markets is huge. As a consumer today, we can measure our heart-rate, steps taken, and calories consumed. We can monitor an enormous number of societal issues, from stock performance to talent show voting, through a bewildering number of channels, from Twitter and Snapchat to webinars and (now almost old fashioned) e mail.

So how might these technologies benefit the operation of an electricity system?

Imagine a system which intelligently self-manages variable consumption (through demand side management and control), variable generation (through renewables), whilst monitoring and controlling storage, and concurrently reacting to short term pricing signals on the supply market to optimise each of these variables. The opportunities for energy saving, cost reduction and carbon reduction are huge.

Imagine networks that are monitored by thousands of low cost sensors that are installed across the network, silently measuring volts and amps ubiquitously and intelligently re-configuring networks to optimise load flows to achieve consumption requirements whilst minimising impact on assets and managing around fault to optimise availability.

Imagine assets whose condition is monitored by thousands of low cost sensors which advise operators if and when any intervention is needed (replace, repair, refurbish) and concurrently inform an asset register to give live feed on network health and asset value.

Imagine a system that actively communicates with operators and consumers, providing them with the information they need, and only that information, to assist in efficient and effective network operation, to reduce risk of injury from unsafe assets and to guide consumers toward efficient consumption and control of energy to minimise costs and carbon usage.

All of these, through handheld devices, are in common usage today.

Some of the technologies needed to monitor the relevant parameters are not yet available at a cost that will allow ubiquitous distribution….but they are coming. The communication and control devices needed to co-ordinate and configure the networks and inform operators are not yet available at a cost that will allow ubiquitous distribution…but they are coming. The software systems to manage the data and communicate with operators and consumers cheaply and effectively are not yet programmed, but they are also not far away. Bringing all of these together will represent a revolution in how energy networks interoperate with humans.

## 3.2 Network Asset and Operations Management

As low cost sensing becomes increasingly widespread over the coming decades, more and more intelligence will be made available to asset managers to determine the optimal intervention on their networks. Indeed, real time data on asset health and performance is likely to see a progressive merging of the asset management and operational functions.

Real time data will integrate with operations management, directing intervention to avoid imminent asset failure and to effect repair, upgrade or refurbishment. Fix on failure will become increasingly rare as the cost of monitoring reduces and the opportunity to replace pre-failure becomes more cost efficient.

Increasingly close arrangements will exist with integrated supply chains, with inventory arrangements vertically integrated with forecasted asset supply requirement based on predicted future condition and replacement need. Similarly, equipment manufacturers and developers will be integrated into a condition and failure mode analysis network, developing assets to meet future performance requirement as well as degradation mode analysis.

Operations will be directed based on live performance and condition data, and will be controlled through mobile work instruction devices which simultaneously upload and download asset data and intervention activity.

EA Technology will provide a full range of expertise into this environment. We will provide remotely managed software to collate and process data into intelligence and hardware platforms to migrate intelligence and recommend interventions to the appropriate management levels in asset operations departments. We will provide expertise towards the definition and ongoing refinement of the software algorithms that interpret asset condition and recommend optimised intervention based on performance and condition parameters and trends. We will analyse those assets that catastrophically fail to determine opportunity for monitoring of similar assets to avoid future failure. We will train the asset operations engineers of the future to provide them with the 'line of sight' competence set required to deliver maximum value to their organisations. We will provide field support to assist operations teams to collect, collate and interpret obscured asset performance and condition data.

In short, we will become integral partners to network asset owners in the stewardship of their assets.

## 3.3 Future Energy Systems

If the founders of our organisation had been asked to look forward 50 years, would they have imagined where we find ourselves today? The market place is radically different, with segmentation of supply, generation, distribution and transmission of electricity, compared to an essentially consolidated, nationalised industry. Similarly, the technical challenges of 1966, were around the construction and operation of a nationally integrated electricity system. Our challenges going forward are radically different and EA Technology will need to evolve to address some of the following issues:

Assets that are already well beyond their design life will continue to age and deteriorate. Currently replacement levels are unsustainable and therefore asset renewal strategies will become finely tuned.

New Energy Communities are increasingly emerging that want to manage their own supply, storage and demand. They may, therefore, actively participate in shaping the networks that distribute their power.

Heat and transport are increasingly being electrified, with estimates for 2030 of 3.5 million electric or hybrid vehicles on the roads in the UK and 5+ million homes receiving heating from air or ground sourced heat pumps. This will result in a radically different daily usage profile, which will have to be managed.

A cross vector approach to energy management will become necessary with natural gas as the primary source of space heating being increasingly replaced either by hydrogen sources of heat or through heat electrification. New models of design and operation will be needed.

Intermittent energy sources will continue to increase, requiring much deeper alignment of supply and demand.

Automation of appliances will become a necessary feature of our home environment with much of the electricity being used subject to patterns of control that will require user participation.

Distributed and small scale generation will continue to increase and will place further challenges on balancing supply and demand as well as managing network loads.

The evolving networks will present with new and additional safety risks which will need to be understood and operating practices evolved to mitigate against them.

There will be a significant and long term need to up-skill the workforce to be able to safely operate within this fast evolving environment.

Managing assets that are increasingly being required to operate beyond their design life and their operational specification will bring additional technical and management challenges.

Within each of the above challenges, there are huge opportunities for EA Technology to expand its horizons and build its market share. Our success in doing so will be a function of our ability to grasp this vision and to articulate the technologies and know-how needed to build the energy systems of the future.

## 3.4 Astute – HV Assets – Globally

Industrial owners and operators of electricity networks often face the significant challenge of relying on their networks to ensure that their processes deliver, whilst not having the depth of expertise available to utility operators to manage their HV assets. At the same time, their HV assets continue to age and deteriorate, presenting increasing risk of interruption to production.

EA Technology is combining its technical expertise in monitoring HV asset management condition and performance with advanced cloud based data communication and management platforms to provide a globally unique HV remote monitoring service. Once a condition and performance benchmarking exercise has been completed, we install sensors at key points on assets to monitor performance, feeding data back via the cloud to our Astute Monitoring Centres, based around the world to provide 24 hour coverage.

Critical to this proposition is the delivery of periodic condition and performance reports and early warning alarms to provide opportunity for pre-failure intervention. The monitoring solution will be coupled with diagnostic assessment and tap into our in depth understanding of asset failure modes to recommend the timing and profile of the intervention, whether replacement, repair or refurbishment.

There are multiple channels for delivering this capability, whether directly through our international businesses, through licensed arrangements with service providers, or through original equipment manufacturers.

It will be increasingly common for our customers to buy a ‘no outage’ guarantee, whereby we back our own engineering competence and provide insurance to our customers such that we will meet the costs of replacing those assets that have failed if we do not identify their imminent failure.

The Astute solution will further mark the progression towards the provision of embedded solutions to our customers.

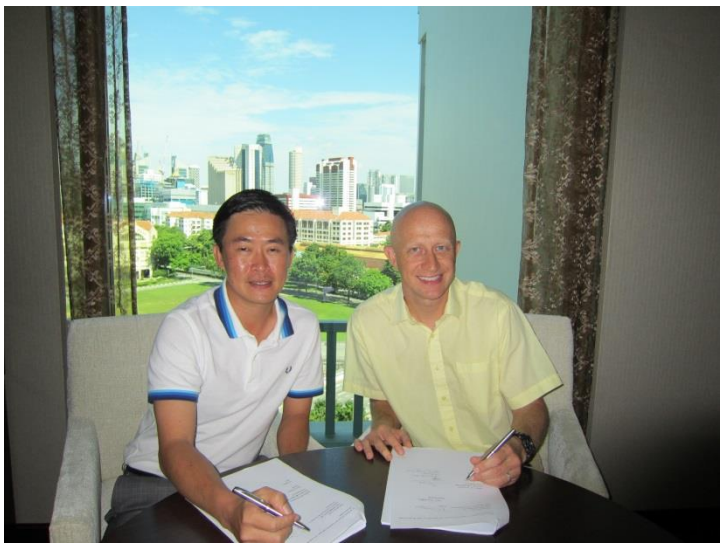
# 4. The Global Stage

## 4.1 EATAP – Brimming with Eastern Promise

EA Technology Asia Pacific is one of the most exciting areas in the globe for its economic growth and its technology acquisition. EA Technology has been working in China since the turn of the century and established its trading subsidiary there in 2008. The Chinese were particularly curious to adopt CBRM as an asset management methodology, often using the approach to manage the growth of their asset base. Singapore Power have been a fantastic partner in their leading approach to asset monitoring. Their network performance is second to none in the world and this is led by a deeply proactive approach to the avoidance of asset failure. We established our South East Asian business there in 2011, opening EA Technology Asset Management Pte, with its founding Managing Director, Victor Chan, being drawn from the local electrical utility to bring his local knowledge and operational expertise. Since that time, we have deepened our distributor network around the region, with active business in Vietnam, Malaysia, Indonesia the Philippines and Thailand. All of these markets have huge potential for growth and are likely to represent an increasing proportion of our whole business.

As well as our operating bases in Singapore and Shanghai, we have a team providing the full range of services in Australasia, with an office in Brisbane, led by Neil Davies, and staff based out of both Australia and New Zealand. Our staff in Australia not only work closely with their colleagues in South East Asia and China, but also work across a range of sectors in Australia, from the huge mining sector to the local electricity distribution network operators. The Australian utilities are also well regulated and adopt global best practice in asset management. Their continued investment in their network has drawn on the strengths of EA Technology's expertise from asset management strategy to meeting the decarbonisation challenge, provided through methodologies like Transform.

The opportunities in the Eastern Hemisphere are likely to feature highly in our future growth. Their early adopter culture has driven the development of many of our new technologies and we expect their hunger for continuous improvement to continue to move us forward.


Singapore Office Opening

Bali


Singapore


Brisbane?

## 4.2 EMEA – Europe, Middle East and Africa.

The 'old world' in some people's eyes is not only the home of the company, but is also the region of the world in which we have the deepest connections and the greatest value to add.

Europe has the longest established electricity networks of anywhere in the world. These mature networks were certainly built to last … gold plated some might say, and they have definitely stood the test of time. But they were designed to last 25, 40, maybe even 50 years and in many cases the assets are now showing their age. A progressive replacement programme is slowly increasing in pace and EA Technology is in pole position to assist in prioritising the replacement strategies and steer investment towards the optimum benefit for the network operators and their customers.

Interestingly, as energy efficiency measures and renewable energy generation increase, so the morphology of the electricity distribution networks change. In the UK, for example, there is an increasing migration of the population to cities and whilst this puts added pressure on the networks, which are now very much at capacity and require upgrade, the rural areas of the country are seeing reductions in energy consumption, with some assets risking being stranded. Certainly, extending the life of assets rather than replacing one that might be increasingly redundant is more and more relevant and solvable using our online monitoring technologies.

We have been delivering condition assessment services, instruments and asset management consultancy to industrial companies and network operators for well over a decade in the Middle East. We have built strong relationships with companies in the Emirates and Saudi Arabia and now have staff permanently based in Riyadh, Abu Dhabi and Bahrain. The conditions for delivering our services are amongst the most physically challenging in the world. Our engineers have suffered snake strikes, extreme heat and a lack of alcohol, sometimes for weeks on end. The latter seems to the most difficult to get used to!

We have a strong history of delivering instruments in South Africa whose network continues to grow at a pace. Other African states remain at an emerging stage of maturity and are likely to attract our expertise increasingly more over the coming decades.

Abu Dhabi?

## 4.3 The Americas – The Land of the Free

The Americas offer huge opportunity for EA Technology's services. Early adoption by some of the utilities of our instruments led to opening an office in Florida. Whilst we saw some good orders, creating a sustainable income stream was a challenge, so we closed our office in the South of the US to open an entirely new business in New Jersey in 2013. Since then, we haven't looked back. Our founding President, Bill Higinbotham, has a great depth of knowledge both across the technology area and in developing presence across this huge territory.

We have now delivered our technologies across a very broad range of geographies, including Bermuda (a popular destination for our consultants), Canada, California, Mexico, New York … basically across pretty much the whole continent.

The challenges remain the 'tyranny of distance' of course and promoting the adoption of technologies to a nation that already sees itself a global leader in this area with many strong, indigenous suppliers. We have sought the aid of a number of agents across the region to support our range of services and to represent them to their local industrials and network operators. These 'feet on the ground' have been invaluable in bringing our capabilities to a very broad audience with a huge appetite for increasing network reliability and reducing the costs of network operation. Some leading industrial companies have been early adopters of online condition monitoring of the HV assets and our enterprising team has also developed the very first device to increase the safe operation of HV asset condition instruments. This device is now selling around the world.

We are currently scratching the surface of the opportunity in the Americas. With over 2000 municipal network operators across the US, the potential to assist them in managing their investment programmes as well as reducing the incidence of catastrophic asset failure, is huge.

# 5. People

What makes EA Technology so special? The answer to that is easy – it is its staff. Below are some views from some long-standing EA Technology employees who have shaped the company over the five decades of its existence.

## 5.1 Starting in the 1960s – John Reeves

I started, as a Research Officer, in September 1967 and it was my first proper job. I was only twenty at the time so everyone else seemed so much older and wiser than me! After four years I was lucky enough to be awarded an ESI Scholarship to study for a PhD at Manchester and it was there that I started my high voltage (HV) partial discharge (PD) work.

At the time, several of the Area Electricity Boards had experienced explosions due to the breakdown of the insulation in their older switchgear. It was known that PD measurements were the best way of detecting incipient insulation faults but, when PDs were detected, they had to be located by a process of elimination. This method was very time consuming and expensive. I visited Mr Baggott, ACE, London Electricity and he explained how they desperately needed a better method of locating PD sites. He also added that the problem would not be easy to solve but he wished me well with my studies and he promised me resources and facilities to help me with my project. He honoured his promise and I did manage to find a method of locating PD sites (to an accuracy of 100mm typically; they would have been delighted with 1m) and many years of close collaboration followed between LEB and ECRC.

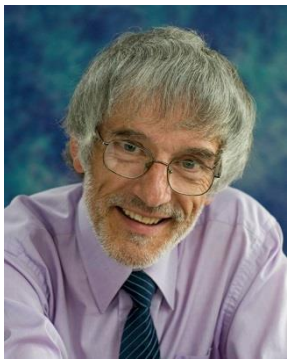
When I returned to Capenhurst after my scholarship, I continued with my PD research. At that time, the PD location technique was too specialised and the test equipment too expensive for the Boards to undertake themselves. ECRC therefore set up a team to make the measurements and we soon found ourselves providing a service to all the Boards.

I was also keen to develop a method of PD detection and location that could be undertaken by any competent person. In 1979, I invented the Transient Earth Voltage (TEV) method. These PD measurements are made by applying capacitively coupled probes to the earth metal cladding of the plant under test. With this method there is no need for HV test gear and no need to take the HV plant out of service. Thirty seven years later, EA Technology has a splendid range of TEV instruments using the latest technologies which it sells all round the world!

After I finished my Scholarship I was obliged to continue working for the Company for two years. In those days, at ECRC, we enjoyed the academic freedom of research, much like a university, but with the bonus that the Company would back winning ideas with serious money. It was just the kind of job I was looking for. I also thoroughly enjoyed working alongside so many interesting colleagues with such a diversity of talent so, not surprisingly, rather that stay for two years, I stayed until I retired!

On a lighter issue, I did enjoy the Christmas Shows both as a member of the audience and in the cast. It's a sign of a vibrant company when it can take a gentle ribbing. The Christmas Show also provided a conduit for feedback to the management, something that I know Trevor Churchman appreciated.

## 5.2 Starting in the 1970s – Mark Bertinat



I joined the company in 1974. On my first day, my new office mate took me round the site, showing me what went on and introducing me to "important" people. These ranged from bright young scientists who could help me in my work to old lags whose main occupations seemed to be carrying out a vast range of "foreigners", i.e. jobs for home.

The most interesting character I met during my time at EA technology was Gordon Dyos, an early office mate; his interests included electromagnetic guns, ball lightning, the nuclear-attack strategy of Clwyd, running a tractor and logging company, and "renovating" old buildings, keeping the bare minimal of the original.

The most interesting project I worked on was determining the effect of woodpecker holes on the strength of a pole as a function of whole size and shape and location up the pole. I had to learn some engineering off my Dad.

I feel the most valuable contribution I made to the company was organising monthly technical colloquia, monthly rambles, annual Christmas shows, annual handicap and inter-building running races, and the occasional one-off visit e.g. to URENCO's centrifuges. The most valuable contribution I feel I made to the industry was co-ordinating the STP Module 2 for 15 years and driving its overhead-line ratings projects.

The funniest thing that happened during my time working for the company was directing some very funny people (Les Smith, Peter Boyce) in the Christmas Shows of the 1980s.

The work has been very varied and enjoyable, and this has been the most important thing that made me work for the company for so long.

The biggest change that took place during my employment with the company was privatisation, when we moved from a "holiday camp" existence (you have £13 million, what would you like to work on?) to a "selling ourselves" existence (persuade us we would benefit from giving you money).

## 5.3 Starting in the 1980s – Karen Dodd

I joined the company on 30th March 1987.

There were no inductions or buddy schemes back then – it was straight to work – I was introduced to the Post Room, sorting and opening the mail!

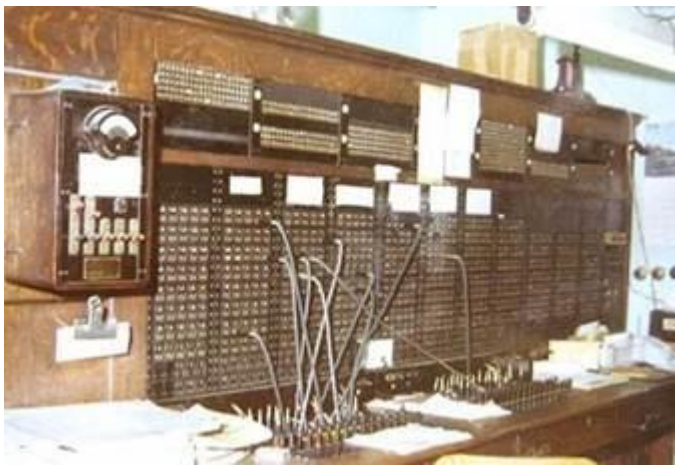
The most interesting project I worked on was the implementation of the Cascade HR & Payroll system. I loved being involved from day one in the cleansing and transfer of data from the old outdated PS2000 system. The difference it has made to record keeping and report printing is fab!

The most valuable contribution I feel I've made to the company is paying everyone on time.

The funniest thing that has happened during my time at EA is when I came into work to find a feral cat who was only days old, had been abandoned near Stores. I placed her in a box and hid her under my desk to take to the vets after work. However, during the day there was a fire drill so I had to evacuate the building with the box and answer some awkward questions! The cat rules the Dodd household to this day!

Why have I stayed at the company for so long? I enjoy my job, benefits and the people (..well the majority!) It's a short commute from home. The flexibility with part-time working I had whilst my family were growing was great.

The biggest change that has taken place has got to be technology! When I started, we used manual Golfball typewriters, took carbon copies and used tipex for our mistakes! The old telephone exchange was so antiquated – a pbx system – that looked something like this …



The biggest mistake I have made during my employment would be whilst working the last rota on Reception. I forgot to lock the main door – I still get reminded of it by certain people!

## 5.4 Starting in the 1980s – Bernard Duffy

I joined ECRC on the 9th Otober 1989 as a band 4 site maintenance electrician, looking forward to my first permanent position after years of working as a contract electrician. I was given a site tour by the then electrical foreman Glyn Hughes and introduced to the rest of the site maintenance team which comprised of approximately; 10 electricians, 4 fitters, 2 painters, 3 sheet metal workers, 2 joiners, 1 bricklayer, 2 welders, 2 plumbers, 8 mates.

I was then told to take all my tools home by Glyn, as any tools required can be requested from stores. It was like tradesman heaven.

In 1996 I joined the technicians in C26 where I had the privilege to work with the best engineer and friend I had ever met Pat Chetwood. Pat was dedicated to his work, inspirational about how he met challenges and a true friend. However, working with Pat in Northern Ireland, carrying out tower testing, I made my two biggest mistakes. Never photocopy an OS map into black and white, as rivers do not stand out and you can easily walk over 10 miles through the country looking for the next crossing. Always be on the lookout for army patrols, as you attach a box with trailing leads to a steel tower which overlooks an army base. This lesson I learnt after being challenged by an army patrol at a tower, and turning around to see two rifles pointed straight at me.

The funniest memory I have is soaking a BP engineer in screen wash while he talked to Mark Wilding through the van passenger window. I was preparing the van for the long drive home from Grangemouth, and actually pulled the lever not once but twice to clear the windscreen. Only then did I see the BP engineer from the corner of my eye dancing around to avoid the spray. After apologising profusely, the hardest part was to keep a straight face until we were outside BP's main gate.

I have been and am currently fortunate to work with some exceptional people, carrying out a huge variety of work. I have in the past come on to site in the morning, to be at home by 10 packing a case, on my way to a ferry or airport by lunch. It is the people and not knowing what is coming next that has without any doubt kept me here for so long.

## 5.5 Starting in the 1990s – Mark Wilding

I've been in the company for about half of its 50 years. I joined the company in 1991 just after privatisation, missing out on the share save schemes and most of 'the good old days' and astonished at the talent that Capenhurst had attracted – whatever you needed to know, there was someone at Capenhurst you could talk to who knew the answer and what's more, they were happy to share it with you. It was like Wikipedia but with people.

I joined the newly established services team to deliver services to the electricity companies; exploiting innovation that had been developed pre-privatisation and applying it for real on electricity networks and where people were actually paying money directly for the results – a real change in commercial model. I spent a lot of time introducing new technology and thinking in DNOs and PNOs in the UK and then further afield with stints in Singapore, Malaysia and New Zealand.

People are definitely one of the reasons I've stayed all this time. A constant over all the time I've been here has been the great sense of team. There have been and continue to be so many great people who are committed, approachable and purposeful. A second is opportunity. I've been in at least nine different roles since joining the company and never been short of challenge, learning and personal development. The company has a way of developing an emotional and lasting bond with people – a real sense of being part of something good

## 5.6 Starting in the 1990s – Ralph Eyre-Walker

I joined the company in 1999 as a Year in Industry Student and I returned in 2004 as a graduate.

On my first day, as a student, I can remember going to a Team Meeting with John Baker and meeting people like Graham Earp. I learnt a lot from Harry Fung in the early years of my career and he is the most interesting character I have met here. The piles of paperwork in his office will forever live in my memory.

I really enjoy the helicopter survey work. At times, it is hard work but the combination of engineering , skills, data management and the adrenaline rush from the ideal flying work is ideal for me.

I feel I contribute 110% commitment which I hope has enabled me to provide good value over the years.

As to my most valuable contribution, I would say our impressive delivery of the overhead lines inspection work which led to it becoming the de facto standard for the UK Distribution Industry. Many of our ideas have now been copied by our competitors, however it has been said that imitation is the sincerest form of flattery.

I have heard a story that once, as a student at EA Technology, I had a hangover and fell asleep under my desk. I can't remember if that story is true though!

The most important reason why I have stayed so long is that the managers have always treated me fairly. Plus, I enjoy what I do and only have a short commute.

The biggest change by far to have taken place during my employment has to be the redundancies in 1999 followed by employee buyout. The biggest change since then has been the restructure at the start of FY16.

As to mistakes at work, everyone makes them and I've made lots! I haven't made the mistake of making the same mistake twice yet though.

A reflection on the company that I would like to share is that we are a great team of people and achieve the most when we all pull in the same direction.

## 5.7 Starting in the 2000s – Chris Arthur

I started the company in 2007 on contract, and full-time in 2010. On my first day, I flew in a helicopter over the sunny skies of Kent (as part of the Overhead Lines team).

I have met many interesting characters at the company, however if I had to single one out, it would be Andrew Rogerson; he has a huge amount of knowledge and experience around PD, Switchgear, Transformers, Cables and more. Plus, he has an ability to unselfishly share that knowledge by giving unending amounts of guidance, encouragement and time.

The most interesting project I worked on was UltraTEV Monitors, because I was able to tap into my IT/Software background to (hopefully) add some real value to the team.

I feel the most valuable contribution I made to the company was an extended stay in Qatar to help get a large, behind schedule UltraTEV Monitor Project back on track. This contribution earned me The Chairman's Prize for Developing Key Accounts. The most valuable contribution I feel I made to the industry was some 800,000 photographs of Towers that have contributed to all of the UK DNO's asset management strategies.

The funniest thing that has happened to me during my time at the company was Nick Hiorns and I being asked by the photographer during a marketing photoshoot in a helicopter to "look at each other longingly in the eyes." Or, one night during dinner, whilst away doing Helicopter Surveys, having to take Graham Earp to the A&E department to treat his gout. Seeing that Graham was quite upset, I said, "Don't worry, you're in the best place to be treated." He replied, "It's not that I'm upset about - I'd only eaten half my curry. Do you think they'll have bagged it up?" (Missing out on curry is tantamount to the loss of a loved pet to Graham.) Or, still on the curry theme, a certain senior director taking a mouthful of my curry on a night out in Chester, only to realise, after several chews, that it was the hottest dish on the menu.

There are many important things that made me work for the company for so long, the chief of which is the people I have worked with. However, the willingness of the company to allow people to change roles and therefore develop their transferrable skills is an important factor.

The biggest change that has taken place in the company during my employment is the change from Silo'ed teams to Proposition and Resource based structure. The biggest mistake I have made during my employment is deleting an entire memory card's worth of images (some 3000 photos) after flying a helicopter sortie for CE Electric (now NPG). Fortunately, Richard Ash was on hand, back at the office, to restore them!

## 5.8 Starting in the 2010s - Bill Higinbotham

I joined the company in August 2013 when EA Technology LLC (USA) was formed. At that point the US company consisted of just a file folder.

The first day we officially opened for business (before we even had keys to the office), I took a call from a customer who was screaming mad about a potentially large order. I agreed to get on a plane anywhere that day and go see him because clearly he needed a little customer care. His office turned out to be 3 miles from my house. With a lot of help from Gareth Devine, Stuart Aird, Dave Howson, and Chris Arthur, we turned this very irate man into one of our best customers.

My most enjoyable project to date is when we executed a large job for a utility in Michigan and it was very interesting due to the breadth of work being done. There were lots of different activities over 12 months and it all went amazingly smoothly, from a perfect proposal to an excellent condition survey, to excellent maintenance recommendations that resulted in a happy customer.

My reflections on the company are as follows.

While having the lofty title of “President”, I recall a three-day period when I went from being on my knees beside a transformer in northern Michigan helping to sample oil, to giving a presentation to the CEO of a large utility, to sitting at my desk making cables. Working for EA Technology varies every single day.

# 7. Places (from the Decades)

Do you recognise the places? A few have changed drastically – some not so much.

No Link Corridor


Cars looked different

There was a pond

# 8. References

[1] Page XX to YY (if relevant), “Report Name”, Report Author, Report Publication Organisation (if relevant), Year of Publication;

[2] Page XX to YY (if relevant), “Report Name”, Report Author, Report Publication Organisation (if relevant), Year of Publication;

# Appendix I  Names & Leaders

## Company Names over the years

**Electricity Council Research Centre (ECRC) - 1966 -1989**

**Electricity Research Centre (ERC) - 1990**

**Electricity Research and Development Centre - (ERDC) 1990 -1991**

**Electricity Association Technology Limited -  1991 -1993**

**EA Technology 1993 -**

## Company Leadership

**Trevor Churchman – 1965 – 1982 and  jointly 1982 - 1986**

**Matt Cowan – jointly 1982 - 1986 and 1986 - 1988**

**Carlos Lopez Cacicedo – 1988 – 1990**

**Stuart Exell – 1995 – 2000**

**John Walker – 2000 - 2002**

**Alan Sibley – 2002 – 2004**

**Robert Davis – 2004 - present**

# Appendix II Licencing

## A selection of licensees

| Product | Manufacturer / Supplier |
|---|---|
| Aluminium Soldering Flux | Borax Consolidated Ltd |
| Battery Monitor | |
| | |
| | |
| | |

www.eatechnology.com
Australia | China | Singapore | UAE | Europe | USA

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# Global Footprint

We provide products, services and support for customers in 90 countries, through our offices in Australia, China, Europe, Singapore, UAE and USA, together with more than 40 distribution partners.


# Our Expertise

We provide world-leading asset management solutions for power plant and networks.

Our customers include electricity generation, transmission and distribution companies, together with major power plant operators in the private and public sectors.

- Our products, services, management systems and knowledge enable customers to:
- Prevent outages
- Assess the condition of assets
- Understand why assets fail
- Optimise network operations
- Make smarter investment decisions
- Build smarter grids
- Achieve the latest standards
- Develop their power skills

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