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Left: The technique of 'foiling' both hulls out of the water was a gamechanger; Right: The huge AC72 yachts provided a true workout for the crew!

On-board for the
America's Cup

In 2013, the historic America's Cup took place in San Francisco. Although this was the 34th time this series of races had been competed, typically the event had mainly been of interest to die-hard sailors and those in the know only. This year was different – a combination of race organiser Larry Ellison's vision to set the race in a spectacular and accessible venue, coupled with wonderful TV coverage and highly informative graphics, enabled even those who know next to nothing about sailing to both see and understand what was going on. A brand new mass-viewing event had been created, with people who had never in their lives watched any sailing suddenly hooked. Right at the heart of this remarkable TV event was the SIS LIVE Special Cameras team led by Paul McNeil, SIS LIVE America's Cup Project Leader.

Back in the early summer of 2010, SIS LIVE received a RFP (request for proposal) to tender for the provision of technical facilities for the 34th America's Cup, which would be held in San Francisco in August 2013. As SIS LIVE had worked on the RF reception from yachts at the 33rd America's Cup, we already had a history with the event. SIS LIVE decided to tender for two contracts, the on-board cameras and the RF reception. After a trip to the States in December 2010 for the pitch, we were awarded both contracts and the fun began.

A new vision
Now you might think that securing the contract in December 2010 for the America's Cup in 2013 seems very reasonable

in terms of timescale – until you understand the vision of Larry Ellison, the founder of Oracle and the owner of ORACLE TEAM USA who, as holders of the 33rd America's Cup became the defenders of the 34th Cup. Traditionally, the America's Cup had been contested in single-hull yachts, at 10 miles or more out to sea, but the 34th America's Cup would be competed for in the AC72 class of yachts. These multi-hulled vessels are 72 feet long and 131 feet high (that's 13 storeys) and these would be sailed at an inshore arena-style venue to allow the public to watch from the coastline. The vision was to include the spectacular backdrop of the Golden Gate Bridge at one end of the course, all around the bay, past Alcatraz, finishing 100 metres off Pier 30, right in

the heart of the Bay Area. This would provide a wonderful natural viewing amphitheatre from which to watch the racing with the naked eye, also creating the potential for a TV spectacle never before seen.

The 'kicker' was that before all of this there would be the America's Cup World Series, consisting of six regattas per year, sailed at venues worldwide, in smaller one-make AC45 yachts. Again, these yachts would be multi-hull and the first regatta was to take place in Portugal in July 2011, with a full test of technologies in New Zealand in April 2011. Now those are more like the timelines we are used to!

So SIS LIVE had two contracts to deliver, the on-board cameras and sound, and the RF reception of up to 14 sources from the water and in the air. This article focuses more on the on-board camera systems and sound, as the RF delivery is a complete story in its own right, but I would just say that the results were like being on wire rather than RF and all credit for this goes to Simon Fell, lead RF supervisor and his team.

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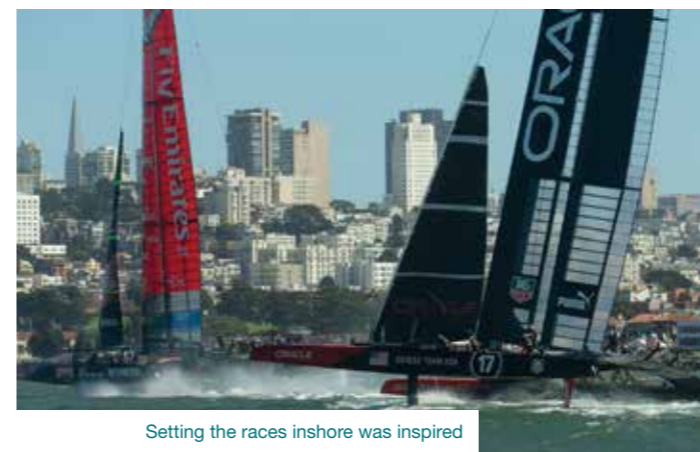Setting the races inshore was inspired

Part of the system
The advantage of winning the two contracts was that we could integrate both solutions on the yachts, rather than having two providers with multiple Peli cases fighting for the same limited space. The other main change was that from day one we were part of the event itself, in that our systems would be designed alongside the boat-builders of the AC45 yachts, enabling the systems to become as much a part of the structure and look as any of the sailing gear. I think this is what made this project so enjoyable from my point of view; I have spent many, many years trying to fit equipment onto moving objects owned and operated by people who would rather we didn't tamper with them. Working as part of the event with our systems written into the protocol was a dream come true.

The basic specification for the AC45 on-boards was for up to four agile camera systems with 10:1 zoom lenses with pan/tilt/zoom and roll. The systems had full paint and engineering functions controlled from shore. For the three-year project we manufactured a total of 50 remote heads, utilising the Sony FCB-11 camera module with an added 0.6 wide-angle attachment. This camera is a good all-round single-chip HD OEM module. We did find that the wide-angle attachment slightly defocused on the long end of the zoom but as it was all about the wide end on the AC45s this was not a problem. When it came to the AC72 yachts the larger size of the boats meant we were able to remove the wide-angle attachment and make use of the clearer optics and tight end.

We decided at an early stage that the control of these systems would be over IP, which was a departure from our normal UHF. The reason for this was that, for the first time,

> **"**A quad split proved to be a very useful aid that enabled us to colour-match a whole boat while not on the mixer, so as soon as that yacht was selected to go on air the pictures were ready and matched.

©ACEA/PHOTO GILLES MARTIN-RAGET

With six remote heads per yacht SIS LIVE had all angles covered

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With the Golden Gate Bridge as one of the boundaries this truly was a magnificent arena

> "If the action was on the windward side and those cameras were on air we could set the yacht cameras on the other side to safety shots and clean the lenses etc, ready for when the boat tacked."

all the umpiring and data information for the graphics and race management would be achieved via a secure IP network over the entire race course. This was part of the fantastic race graphics and race management put in place by LiveLine under Stan Honey.

We had up to ten yachts fully equipped for the fleet races during the AC45 regattas, with seven available on the mixer at any one time. From each of the seven yachts we could see two of the cameras delivered in Mpeg 4 along with up to ten sound channels. If required, we could show a quad split of all the cameras on one channel while still having a race camera on the other channel. The quad split proved to be a very useful aid that enabled us to colour-match a whole boat while not on the mixer, so as soon as that yacht was selected to go on air the pictures were ready and matched to crash straight into the live feed.

The systems were operated via a bespoke controller that enabled the user to call up any yacht that was not under the control of any of the other operators. As mentioned, every command had an IP address so it made for a very fast and fluid way to be able to chase the action. The operator could switch to any two cameras from the four available

on his boat and could also control a second boat's worth of cameras via a second controller. To add to this system, we had a master control that could jump in to any of the systems to help with the pre-positioning and colour-matching. In essence, we were working on the cameras that were not live to air to give a safety wide with the right colours.

In San Francisco

After two years of the AC45 regattas came the main event: three months in San Francisco for the 34th America's Cup, preceded by the Louis Vuitton Challenger Series, the winner of which would go head to head with the defender, ORACLE TEAM USA. Enter the magnificent pieces of engineering that are AC72 yachts. You really can't imagine how big these boats are until you have stood on one.

So, for us, it was much the same principle as delivering the AC45 coverage, only with more cameras, six remote heads and one fixed camera, more radio mics and new yacht looms. We ran two complete on-board systems on each yacht and combined the four picture and sound sources onto one RF channel (I did say the RF is another story – it's all a black art to me!). So the operator still had two controllers but now

One of the SIS LIVE innovations was placing the aerial and RF power amp at the top of the mast

Paul McNeil fitting the in-house designed 5.0 surround sound module that fitted under the central rear remote camera

they were working on one yacht only and could see four cameras out of the seven on-board at any time. This is where being able to jump in to control from the back seat came into its own. If the action was on the windward side and those cameras were on air we could set the yacht cameras on the other side to safety shots and clean the lenses, ready for when the boat tacked. In this way we could prepare usable shots for the operators to take as soon as they were needed. The action was so fast that being able to pre-set usable shots really was a winner.
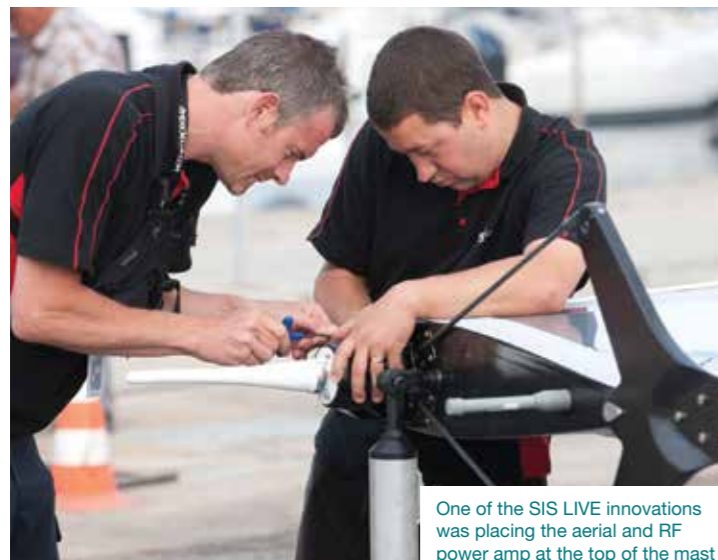
Camera 7

The new fixed camera became the star of the show even though it had not been part of the original spec. It was Team New Zealand who found, during testing of their prototype boat, that they could make their boat 'foil' (getting both hulls out of the water on the retractable foils). This was a complete game-changer for the speed of the boat and all teams had to go the foiling route to have any chance of winning. It presented us with a problem though as all six remote heads covered above the net, at deck level, and could not get the spectacular shots of the boats foiling with both hulls skimming the tops of the waves on two carbon-fibre surfaces smaller than an ironing board. At some speed we designed what became known as 'Camera 7'. This was a single-chip camera with a fixed 127-degree lens mounted on the post below the forward beam known as the 'dolphin striker'. This gave stunning shots of the foiling and provided the commentators with a perfect illustration of what would become the story of the Cup: Could your boat foil better than the others?

Lens cleaning

During the AC45 regattas we had found that our lens-wiper system on the heads worked well while the boats were racing but when they were not racing salt drying on the lens

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Kiit from the two yachts after the Final

> Working as part of the event with our systems written into the protocol from day one was a dream come true.. our systems would become as much a part of the structure and look as the sailing gear.

became an issue. This would not usually be a problem as on-board cameras are normally only used for race coverage, but as our pictures and sound were so good the production always did a live two-way interview from the boats at the end of the race with the winning skipper and commentary team. To counteract this issue of salt drying, we instigated a washing system that was self-contained and wireless; essentially a module that sat in a holder beneath the camera head with a water tank and 9-volt battery. We developed a set-up in-house that would fire a jet of water three times at the camera every time it was pointed at the washer for more than three seconds. This was achieved by registering the magnetic field local to each camera position every morning and then having the circuits measure a rise in the magnetic field when the camera was left facing the washer. We were very proud of this solution to the problem and it worked brilliantly. We did encounter a problem one night though as we were returning from ORACLE TEAM USA's base with five of the modules in the back seat of the hire car (you can see where this is heading). We stopped at a set of traffic lights and all five systems fired off at the back of our heads. It was like the fountains of the Bellagio Hotel, without the laser light show! There must have been something under the road that set them off. After that we turned them off for transport. It did give me an idea for an alternative car wash though as the inside of a car is always neglected!

Integrated experience

As mentioned, the whole yacht camera system was bespoke to this project and fully integrated with the on-board RF delivery; hence, Gigawave (as it was at the time, Vislink now) was involved throughout with the joint design and manufacture of the system. It was evident from very early on that, in order to meet the timelines, a joint engineering approach with SIS LIVE would be needed and I must say that working with like-minded engineers to a common goal was a very fulfilling experience.

I think the sound is also worth a special mention in its own right. We are used to the pictures telling the story of the speed and event action, but we all know that this is only half the story. For the America's Cup final, Paul Stewart, the SIS LIVE lead sound engineer on the project, had 14 channels of sound coming off each of the boats. Between the 5.0

bespoke surround sound module, the radio mics on six crew members, two hull mics, as well as deck mics, being able to hear every command from the crew along with every creak and strain of the rigging really enhanced the feeling of speed given by the pictures.

So, that is a potted summary of the technical background to the event. Hopefully you all saw some of the output of the live programmes from San Francisco in the summer. As it turned out, the outcome of the event with the Americans coming from 1–8 down to win 9–8 was the stuff of legends and could not have been more exiting; Sir Ben Ainslie coming to the rescue of the Americans brought a huge smile to all the Brits working on the project. The reality, of course, was that all the resources Team ORACLE had in San Francisco, coupled with the world-class sailors they had on-board, meant that their yacht just kept getting faster each day. On the other hand, Team Emirates New Zealand had a very fast boat coming out of the Challenger Series and, after a month of competitive matches, was well race-ready. However, after some very bad luck plus the might of the America's (and, of course, Sir Ben) they just came up short.

On a personal note, I would like to say how proud I am of the SIS LIVE team of dedicated engineers that made this happen. It was just two weeks after our return from San Francisco that we found out SIS LIVE was to close the Outside Broadcasts business. Talk about highs and lows. As we all know in this business, hopefully this just means a new T-shirt for the team under a new owner. Here's hoping…

The SIS LIVE team with Sir Ben Ainslie

Fact File

Paul McNeil worked for 34 years at BBC Outside Broadcasts before the unit was sold to SIS Link and became SIS LIVE, so a total of 39 years in Outside Broadcasts in all.

Paul joined the BBC OB department Mechanical Workshop in 1975, rising to Manager in 1982. During this time the birth of miniature cameras in the industry occurred, although 'miniature' was a relative term. Integrating these cameras onto sporting events led to a raft of new mechanical challenges and Paul was asked to head up a new department to encompass their rapidly growing use. This was in 1985… and so the Special Facilities department was born.