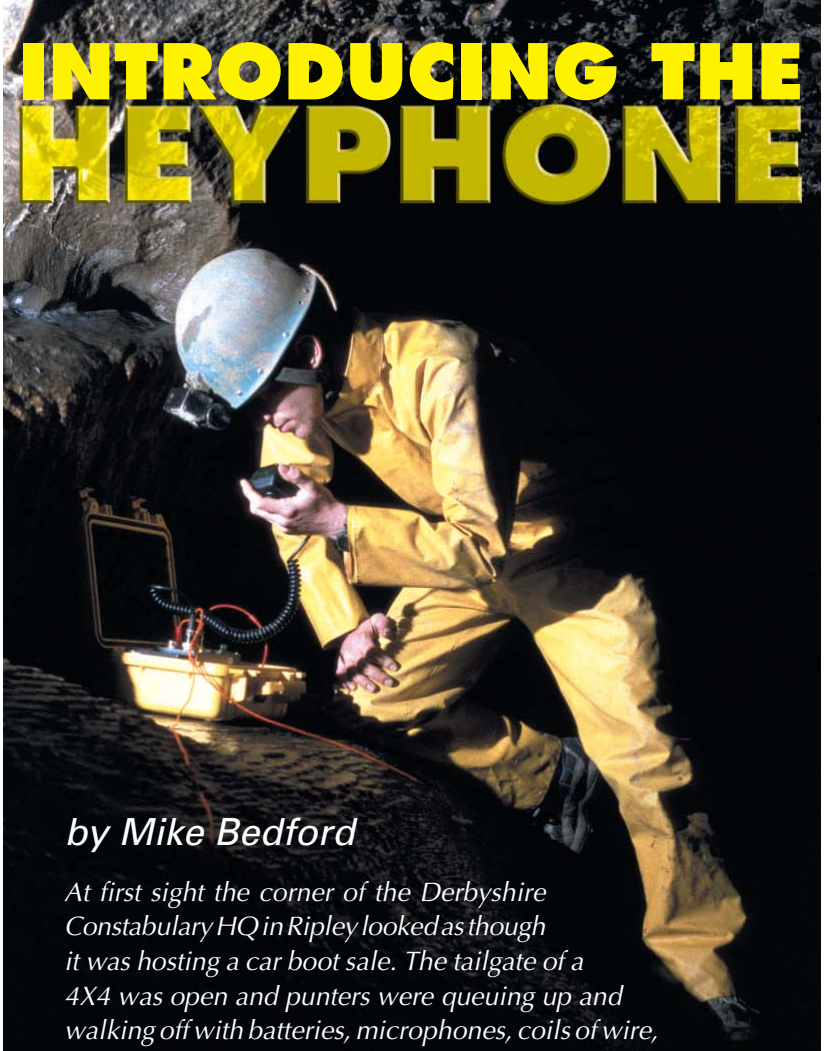
INTRODUCING THE HEYPHONE



by Mike Bedford

At first sight the corner of the Derbyshire Constabulary HQ in Ripley looked as though it was hosting a car boot sale. The tailgate of a 4X4 was open and punters were queuing up and walking off with batteries, microphones, coils of wire, PeliCases and mysterious looking grey boxes – complete with switches, sockets & lights. But although this was the first day of April, it was no joke. The vehicle in question was owned by the British Cave Rescue Council's Equipment Officer 'Jopo' (Brian Jopling); the event was the BCRC's AGM; and those strange grey boxes were 'HeyPhones'. So what is a HeyPhone and why has it produced so much interest among the rescue community? Here we take a look at an important new piece of equipment in the arsenal of the UK's cave rescue teams.

The Molefone

The word 'Molefone' is a familiar one to cavers both in the UK and abroad. Developed by Bob Mackin at Lancaster University, this of course was the first practical cave radio. Ordinary radio waves are blocked by rock. The Molefone, though, uses low frequency induction, which allows it to provide through-rock communication to a depth of a few hundred metres. Rescue teams no longer remained out of touch with the surface controller for hours on end and as a result cave rescue was revolutionised. But … all good things come to an end!

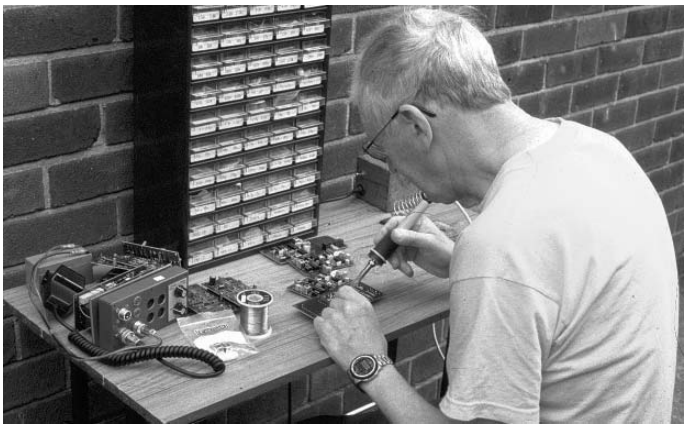
In an era of built-in obsolescence, of PCs which are hopelessly inadequate after just a few years, it is really quite amazing that the Molefone has served the rescue community so well and for so long. But it is asking a lot of any electronic equipment to survive a single trip into a cave, let alone fifteen years' worth of rescues. It is a tribute to Bob's engineering that the Molefone had such a good innings, but as of a few years ago the UK's cave rescue teams eventually started to report failures. To make matters worse, for various reasons, including the obsolescence of some of the components, repairing Molefones turned out not to be a viable option. Worse still, you cannot go out and 'buy' a cave radio – this is one piece of electronic equipment that is just not produced commercially. The BCRC and its member rescue teams had two options – either return to the dark ages with no cave communication or find someone capable of designing and building a new cave radio system.

Wanted – A New Radio

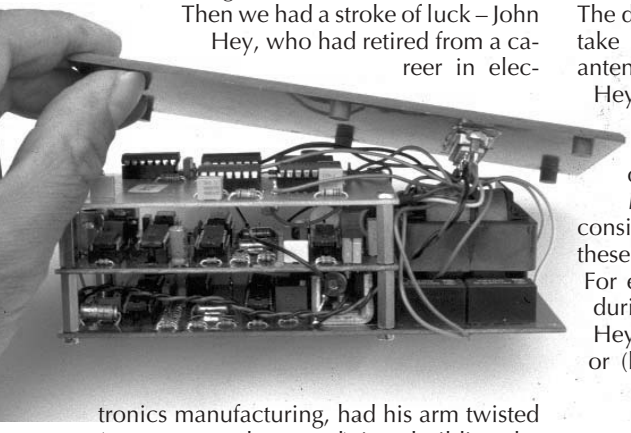
In March 1999 the BCRA Special Interest Group CREG – Cave Radio & Electronics Group – held one of its regular field meetings in Derbyshire. The theme of the meeting was rescue communications and as a result, along with the BCRC, many of the UK's rescue teams were represented. On the Saturday two new cave radios were demonstrated in Peak Cavern. One was the Nicola System, which has been developed for rescue communication in France, and the other was an experimental system designed by John Hey. Both performed very well. Communication over a distance of almost 500 metres was achieved and clear communication was established between the surface and Far Sump, a location that had previously been a communication 'black spot'.

Further tests had been planned for the Sunday, but BCRC Chairman Bill Whitehouse had other ideas. With cave radio experts from France, Belgium, the Netherlands and the UK at hand, this was too good an opportunity to miss. A meeting was called to discuss the BCRC's communication requirements and a project team was set up to develop a new radio system. Eventually it was decided to base the new radio on John Hey's design and the real work started.

Not many people will be interested in a blow-by-blow report of the development but a few facts and figures need to be presented to give a feel for the size



of the project. Designing a rescue radio is one thing: turning the design into 66 working units is another! The concept of a self-build weekend had been discussed. The idea was simple – the components and circuit boards would be purchased centrally, then each of the rescue teams would send members to sit on a production line with soldering iron in hand to knock out the radios. But doubts were raised about the quality of amateur-built radios – reliability was paramount. Next, commercial manufacture was investigated, but this was discounted on grounds of cost…



Then we had a stroke of luck – John Hey, who had retired from a career in electronics manufacturing, had his arm twisted (er sorry… volunteered) into building the radios himself. With John's experience in the electronics industry a quality product was assured. But this was a mammoth task. Almost 200 circuit boards were built up: £7,000 worth of components were used and over 50,000 solder joints were made – all by hand. Not that electronic construction was the only element of the manufacturing process: the radios had to be housed in boxes. But off-the-shelf boxes were not suitable and custom-made boxes would have cost an arm-and-a-leg. This time it was Jopo who came forward to offer his services. Jopo set to work churning out boxes and as John completed the circuit boards they were passed on to Jopo, who completed the manufacture by combining the electronics with the cases.

The HeyPhone

A lot of water has passed under the bridge in the fast-moving world of electronic engineering since the Molefone first saw the light of day. It is hardly surprising, therefore, that the HeyPhone is not merely a carbon copy of the Molefone, having been designed using up-to-date components. The most obvious difference is in the antennas. The Molefone is intended for use with the familiar one metre square 'loop antennas'. These are quick and easy to set up, but they do limit the range. The HeyPhone uses something different called an 'earth antenna'. Two lengths of wire are run in opposite directions away from the radio. In the case of the surface station, tent pegs driven into the ground are attached to the ends of the wires using crocodile clips. Underground, lengths of electric fence tape are used in place of the tent pegs and these are either trodden into the mud or immersed in water and weighed down with rocks. Compared to a loop antenna, a very much stronger signal results so the range is correspondingly greater.

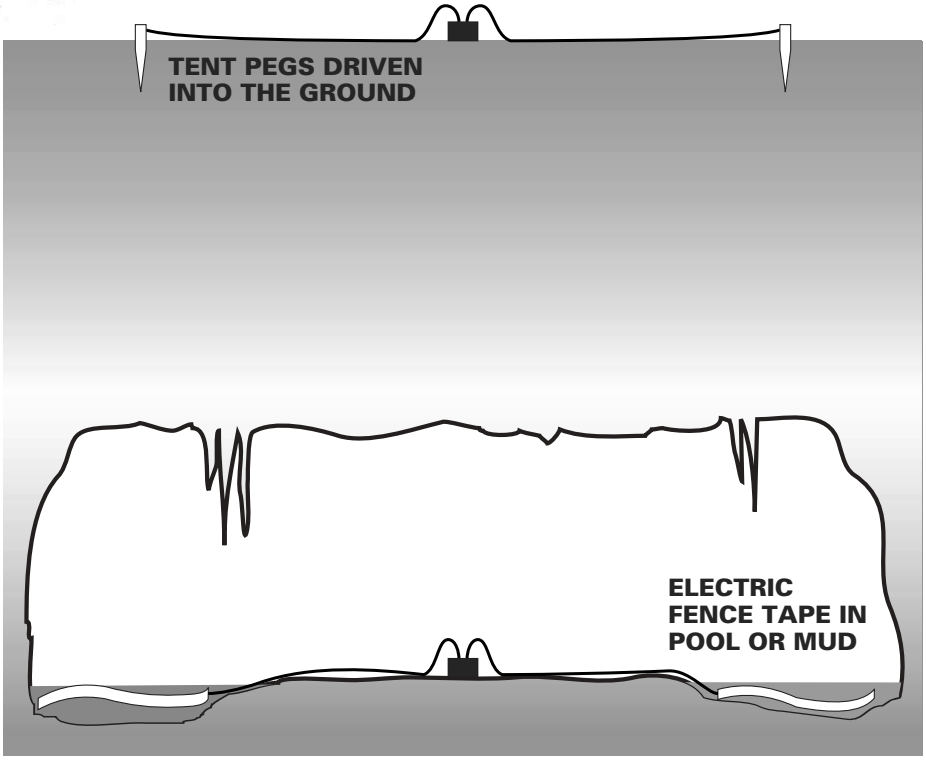
Cave radio experimenters in France have achieved communication through more than a kilometre of rock using earth antennas. The downside of earth antennas is that they take longer to set up. So although loop antennas are not supplied as standard with HeyPhones, the radios are designed to work with loops as an option. It is expected that this will be the popular option for shallower caves.

Many of the other changes can be considered as 'bells & whistles' but even so these make life easier for cave rescue teams. For example, there was much discussion during the design phase of whether the HeyPhone should have a built-in speaker or (like the Molefone) it should use the microphone as an earpiece. Those familiar with the Molefone recognised that the latter approach allows sensitive information to be passed – eg. details of the casualty – without onlookers or the press overhearing. The down side, however, is that one of the rescue team has to have an ear to the microphone at all times, just in case the surface party wants to contact the underground team.

Use of a speaker, on the other hand, allows the radio operator to help out with other aspects of the rescue, yet to hear any calls on the radio. The design of the HeyPhone overcomes this quandary by having a speaker, but also providing a secrecy mode in which the speaker is disabled in favour of using the microphone as an earpiece. Another new feature offered by the HeyPhone is a 'confidence bleep'. When this is switched on the radio transmits a short bleep every thirty seconds. The purpose of this feature is to give the distant operator confidence in the link. In other words, so long as the surface controller hears the occasional bleep, he knows that the underground HeyPhone is within range and working, even though no messages are being passed.

Another unique aspect of the design worth mentioning is the case – designed and built by Jopo. This is a totally sealed case, with all the component parts potted in epoxy resin, and is arguably the ultimate in cave-proofing. However, if something does go wrong, this approach makes any repairs extremely difficult to effect. Whereas we might reasonably expect that a well-designed and well-built circuit board will be reasonably immune from failure, the same is not necessarily true of switches, indicators, sockets and the speaker. Since these items are placed on the front panel they are prone to damage, thus ideally the design should allow them to be replaced.

To achieve the best of both worlds, the HeyPhone is constructed in a two-part case.



The bottom box contains all the sensitive electronics. This is sealed against water (although it can be opened if necessary) and has just a single multi-way connector on its top panel. The top box is bolted to the bottom box and contains all the user controls. It is connected to the bottom box via a multi-way connector. In the event of damage to the user controls, the top box can be removed and repaired without interfering with the main electronics set in the bottom box. What is more, since the top box only contains the panel-mounting components and a few other simple parts, it can be worked on by people with minimal experience of soldering.

In Practice

So how have the HeyPhones worked out in practice since they were handed out at the BCRC AGM?

Not surprisingly, there has been little opportunity for the rescue teams to find out! The foot & mouth epidemic's impact on caving has meant there have been few, if any, rescues and no opportunities to put the HeyPhones to the test. About all that can be reported is that the first use, and probably the only operational use so far (writing in late July), was on a rescue attended jointly by the West Brecon, Gwent and Gloucester rescue teams. West Brecon had received their units earlier than most of the cave rescue groups for a SportsLot audit, following a grant which had been obtained for their purchase. The opportunity to give the equipment the acid test came on Saturday 24th February in Daren Cilau, when a caver dislocated his shoulder some 5 km into the system. Needless to say, the system worked just as expected and allowed the underground team to pass the news that the casualty was (eventually) making his own way out of the cave. With access restrictions now in the process of being lifted, the rescue teams could well have had much more experience with their HeyPhones by the time you read this piece. A new era in cave communication has indeed begun.

The Design

Most people reading this article are unlikely to be interested in exactly how the HeyPhone works or in the specific circuit details. However, BCRC has decided that an important element of the project is to place the design in the *public domain*. This will ensure that the information will be available to enable people to maintain their HeyPhones or to produce add-ons for the kits in future. Although this was not the prime reason for publishing the design, it effectively makes the design accessible to people and organisations other than the UK's cave rescue teams. So, for example, a caving club wanting radios for an expedition could build themselves a pair of HeyPhones. The electronic and mechanical elements of the design have been published in the Journal of the Cave Radio & Electronics Group and back issues are now available. In the fullness of time the design will also be placed on the Internet.

If you would like more details either look at CREG's Web site: **www.bcra.org.uk/creg** or contact Rob Gill (group contact) at: **creg@bcra.org.uk**