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A VIEW OF THE FUTURE OF BATTERIES

G. T. ROGERS
University of Sussex, Brighton, Sussex BN1 9OG (U.K.)

Although for several decades there has been much research and development effort on batteries and fuel cells there has been notably little real advance in the field. The lead–acid battery continues its near complete domination of the secondary battery field while Leclanché and its offspring alkali–manganese remain in a similar position as primary batteries. Perhaps the small high voltage lithium primary battery is the one significant new battery. Fuel cells enjoyed a moment of glory in the Apollo space programme but have now reverted to being that scientifically ideal power source for all those applications for which it would be ideal. So far nobody seems able to identify any more celestial or terrestrial applications.

The advances in fuel cell technology that came from the Apollo programme point very clearly to the importance of real and well-defined needs in directing and stimulating power source research and development. In this author's opinion, therefore, predictions on the future of all forms of power source must be preceded by questions on the likely real needs for power sources in say the next two decades and then which types of power source are intrinsically the most suitable to develop to meet those needs.

General trends in society are always difficult to perceive in their own time, while their effects on future technologies are immeasurably more difficult, perhaps impossible, to predict because either may take a lead over the other at any moment. The electronics and semiconductor industries have already made enormous advances in the development and application of automatic control devices for defence, security, industrial processes, transport and many other activites from astronomy to agriculture. Most of these are devices that require their own independent power source. This will often be a low current but constant voltage source whose reliability is paramount since the complete device's usefulness and therefore commercial value depends directly on the confidence that can be put on it to function correctly when required. It seems likely that demand for genuine 'fit and forget' equipment will grow in proportion to equipments' proven operational records in this respect.

Chemical batteries have, in principle, a number of advantages for such high reliability applications. Their voltages are determined thermodynamically provided they are used under near open circuit conditions; they can be completely sealed and have no moving parts. Reliability, however, depends on the chosen battery's chemistry being thoroughly understood and individual batteries being made to high standards, particularly of component

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purity and physical construction, seal quality being an obvious example of the latter. These high standards will inevitably make high reliability batteries expensive compared with batteries that are currently mass produced for long established applications.

Control devices with proven records of reliability, however, could become regarded as significant physical contributions towards the insurance of very much larger capital investments in property and goods: a very large potential market that would easily absorb an expensive battery.

Such a market would have to be built on battery performances that could be guaranteed with a confidence matching that of a financial insurance agreement. This will require the development of new non-destructive and hence totally non-invasive battery quality control tests that can be used on complete batteries before service. Ultra-sensitive magnetometric techniques may prove valuable in this respect since a number of long term battery failure modes are associated with very small parasitic current loops that may be present from the beginning of a battery's life.

A need and market for high reliability batteries will stimulate not only the development of more sensitive measurements of battery operating characteristics but also advances in ways of relating precisely, measurements made before installation to long term performance extending, for example, 'bath tub' statistical analysis of battery performance.

So far attention has been directed towards the low current low power long life batteries needed for sensing and control signalling. Response systems will require equally highly reliable batteries but ones with high current output for short periods, for example to open or close a valve. Thermal batteries have features that suggest they might be further developed for such applications. It is well known that they can be made to give very high powers for periods of minutes and that they have almost unlimited shelf lives. As much of their technology is closely allied to that of ammunition making it should be possible to adapt the latter comparatively easily and so achieve comparable performance reliabilities and perhaps manufacturing economics.

Opening and closing valves and perhaps other types of response have well-defined and invariant unit power requirement profiles. Alternate units have opposite polarities that are followed in a regular sequence. This suggests a thermal battery power source analogue of the revolver with a cylinder loaded with alternate battery cartridges connected with reversed polarity and cylinder movement linked mechanically to that of the valve.

Although the future for a manmade fuel cell remains miniscule more than 140 years after Grove conceived it, life on earth is universally powered by hydrogen–oxygen fuel cells. The chloroplasts of green plants use sunlight to form hydrogen and oxygen which is then burnt in the mitochondria, the fuel cell of every living cell. Readers may judge its reliability for themselves. There is much evidence to show that small direct currents driven by distributions of batteries within living organisms play a major role in controlling organismal development and growth and its repair to injuries. Biology evidently finds that battery electric control circuits can be made adequately reliable.