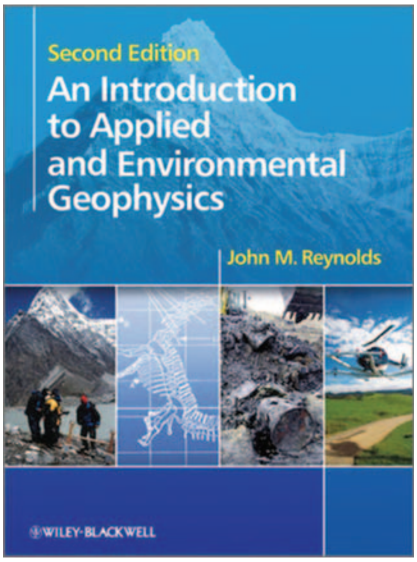
An Introduction to Applied and Environmental Geophysics

by John M. Reynolds
Publisher: Wiley-Blackwell, 2011, 712 pp.
RRP: $79.95 (paperback)
ISBN: 978-0-471-48536-0



Like many of us, John Reynolds, the author of this comprehensive introductory geophysical textbook, has struggled with the challenge of teaching geophysics to students possessing only very basic mathematical skills and a limited background in physics. Reynolds found that many of his students struggled to comprehend the mainstream geophysical textbooks and quickly tagged geophysics as a 'hard subject', best avoided. As a consultant, Reynolds also found it difficult to find an appropriate book that demonstrated to his industry clients the many ways in which geophysics could be used in applied and environmental applications.

With these deficiencies in mind, Reynolds states in his Preface that he set out to write a book that addresses these shortcomings and that provides a foundation for further learning. The result is a book that covers the fundamentals of just about every geophysical method (as best I can tell, only paleomagnetism is missing). The inclusion of a multitude of case studies goes a long way towards illustrating the breadth of applications to which geophysics can be applied, particularly in engineering and environmental science.

After thumbing through the first few pages of this book, a couple of features stood out. First, all the figures are in black and white. This would have been disappointing, but having read the Preface first, I knew that the figures are available online in colour. The provided link (http://www.wiley.com/go/reynolds/introduction2e) takes the reader to a 'Student Companion Site' where the figures can be downloaded for viewing in PowerPoint a chapter at a time. To me this approach is novel, but I wonder whether it would become frustrating if the book were used frequently. However, the cost advantage of printing in black and white is no doubt appreciated by many.

The second thing that stood out is the use of Boxes to present key equations. I have to confess that I often find it heavy going to read a text book riddled with equations, so I appreciated the flow of the descriptive text, uninterrupted by equations to think about and understand. This approach allows the mathematical basis to be examined at the end of rather than during the process of absorbing new concepts.

Chapter 1 is an introductory chapter that summarises the uses of geophysics, planning and designing a geophysical survey, the problems of ambiguity and the need to integrate different techniques and constraints from other fields. This chapter should be a must-read for newcomers to geophysics. It was also pleasing to read here that the ASEG is an 'organisation of note' and to see that *Exploration Geophysics* rated a mention as a source of further information!

The introduction is followed by a chapter each on gravity (Chapter 2) and geomagnetics (Chapter 3). The gravity case studies range from mining applications to glaciological studies, while the use of magnetics in mineral exploration, landfill investigations, and detection of unexploded ordnance, to name but a few, is also covered.

Seismic methods are covered over three chapters. The first deals with the principles of applied seismology (Chapter 4). Chapters 5 and 6 deal with seismic refraction and reflection methods. Both outline the general principles behind each method and discuss the processing and interpretation of seismic data and associated pitfalls. In keeping with the goals of the book, the seismic applications and case studies are dominantly focused on shallow targets, an area where Reynolds suggests that there is still limited literature available. The applications and case studies cover topics such as void detection, landfill investigations, high-resolution profiling on land and over water, and even the morbid topic of locating buried miners.

The next three chapters cover electrical resistivity methods in Chapter 7, self potential (SP) methods in Chapter 8 – but not down-hole techniques – and induced polarization (IP) in Chapter 9. SP and IP are methods less familiar to me, so I read through theses chapters in more detail than some. After having done so, I felt that I had filled (or re-filled) some knowledge gaps. This reinforces my opinion that this book will be useful to many. Case studies include geothermal and mineral exploration, hydrogeology, and detection of leaks in dams (like those in a potentially unstable natural moraine dam in Kazakhstan that lies upstream of a nasty tailings dam!).

Electromagnetic methods (EM) are dealt with in three chapters; one on principles (Chapter 10), and two on systems and applications. Chapter 10 includes mention of the rapidly-evolving marine EM techniques. Chapter 11 covers continuous wave and time-domain EM, while Chapter 12 includes very low frequency, telluric and magnetotelluric methods.

Apparently ground-penetrating radar (GPR) is now the most widely used technique in applied geophysics and GPR is also covered in separate chapters on principles (Chapter 13) and case histories (Chapter 14). These chapters highlight the rapid expansion of GPR from sub-ice bedrock mapping into engineering and archeological applications.

The final chapter, Chapter 15, gives a relatively brief but informative overview of radiometrics and its applications. The case histories include well-known applications in regional-scale mapping for uranium exploration, but also in more surprising areas like the detection of engineering structures within 10 cm of the surface.

Reynolds states in his Preface that his goal was to write a book that provided a broad overview of applied and environmental geophysics, a book that illustrates the power (and limitations) of different techniques, while also improving the acceptance of geophysics as a tool and increasing the awareness of the methods available. I would say that he has succeeded in these goals. His explanations of the principles of each method are likely to be well suited to undergraduates newly exposed to geophysics, industry professionals seeking new ways to address problems in engineering and environmental applications, as well as others, like this reviewer, whose knowledge simply needs updating or refreshing.

Reviewed by Ron Hackney
Email: Ron.Hackney@ga.gov.au

New Year data resolutions

Looks like we are at our last *Preview* magazine for 2011. I want to pass on my best wishes to the ASEG team who have done a great job this year getting this publication out on time despite me always being the last minute merchant.

To the readers, I hope you have a great Christmas and New Year. I look forward to next year when I will be putting articles together on some new technology being released, some old technology coming back from the dead, and some technology that never made it into anyone's Christmas stocking – ever. For now, it's the Top 10 Data Storage Resolutions for 2012 as written by Teena Townsend, my close work colleague.

Each year, millions of people form New Year's Resolutions in the hope of making a change for the better. It's that time of year again, and professionally, it is an opportunity to reflect on all the things that you kept meaning to get around to doing last year, but never actually did. With the start of the New Year, take 10 minutes to look ahead with a fresh perspective and renewed sense of determination. Make a new list of data storage and management resolutions for 2012 and resolve to protect your data (and yourself) from life's unknown beasts.

Here are a few ideas to get you started:

1. **Ensure your data is stored correctly**
   Is it in a data vault with the correct environmental conditions? Is it stacked and boxed correctly?
2. **Know and monitor what data you have**
   Keep records or a database of the data you have and where it is. Know what format and media type it is stored on.
3. **Battle the bulge and do your housekeeping**
   Don't let your data centre get cluttered and dirty. Keep things lean and clean and don't use additional space (if you're lucky enough to have some) as a storage space for junk and legacy equipment – it only creates problems later on.
4. **Backup your data regularly**
   Ensure clear guidelines and responsibilities are understood and that it occurs daily, weekly, monthly or as agreed.
5. **Test your backup data and the restoration/disaster recovery plan often**
   Can you restore data quickly when required? Do you know where it is? Do you have the equipment and know how to restore older archive backup data sets?
6. **Automate your backup as much as possible**
   Backup is boring. Find tools (hardware and software) to ensure that your backups happen regularly in a robust and bulletproof way. The right tape automation and backup software are key.
7. **Store your backup data offsite**
   Use an experienced and knowledgeable offsite data storage provider.
8. **Keep up to date and learn something new**
   Ensure you keep abreast of new technology and solutions. Make time to read, attend seminars and conferences, network and attend industry events. You never know what you might gain and there is nothing to lose.
9. **Resolve to be greener**
   Look to how your data centre or data storage can be more environmentally friendly. Can you use more efficient cooling systems? Are you able to reduce power consumption or choose 'renewable' electricity sources? Can you better use space and resources more effectively?
10. **Use data storage experts**
    If you don't have the time, the experience and/or the knowledge, then call in the experts. The relatively little investment in expert knowledge and experience can literally pay for itself a thousand times over in the event of disaster. Don't fudge it – engage the experts to show you the solutions.

Screen grab from www.elfyourself.jibjab.com

For now, Merry Christmas to all, and to all a good night.

Guy Holmes
Guy.Holmes@ovationdata.com.au

An online alternative to academic and government consortia?

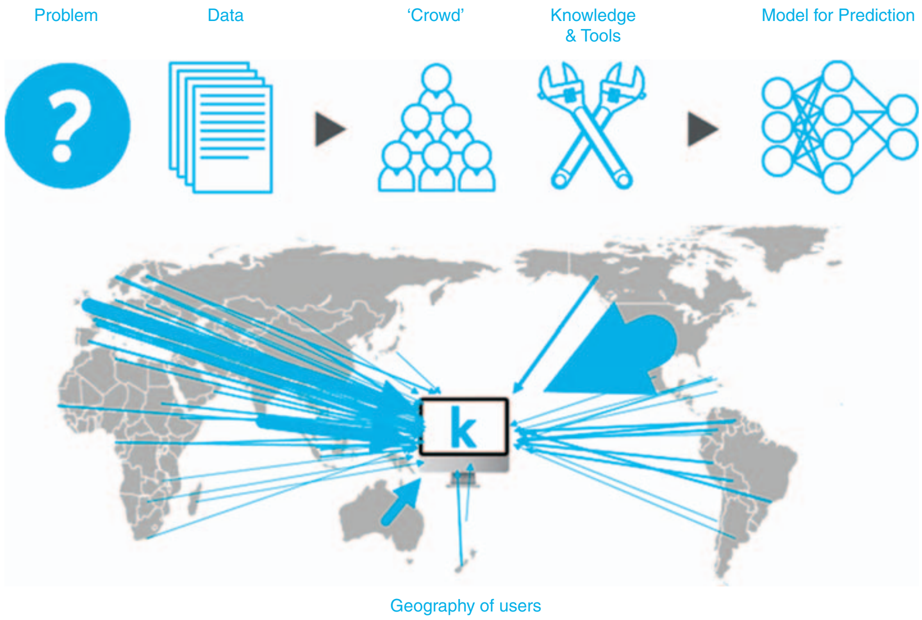
My employer sponsors about 20 academic consortia and university departments worldwide, for a variety of strategic and altruistic R&D reasons. We also participate in a few collaborative R&D projects with government scientific organisations. A common bugbear for all R&D activities is intellectual property (IP). Everyone wants to claim it; such is the universal nature of business these days. The process of making patent applications is arduous even in the simplest scenario where we conceive and develop our own IP, independently of any external personnel or groups. If we choose to pursue innovation with external partners, the contract process involved in formalizing partnerships inevitably becomes bogged down with IP legalese. To quote from the CSIRO website (http://www.csiro.au/multimedia/CSIROandIP.html), 'CSIRO takes the management of its IP seriously. Effective management of IP is important to achieve impact from CSIRO science for the benefit of industry, community and the environment. It is also essential to CSIRO forming productive collaborations.' Most of the aforementioned partners we sponsor maintain a similar ethos.

Academic consortia inevitably dictate that IP is shared between the sponsors of the consortium and the university. My employer maintains a 'portfolio' of consortia based upon their academic specialties, strategic R&D directions and geographical location. It is an expensive process to administer and engage with consortia, their output is rarely aligned with the specific activities of any individual sponsor, new R&D directions occur at best via loose consensus with sponsors, and academia traditionally survives despite layers of bureaucracy and distractions from administrators and the never-ending process of applying for grants. So, consortia sponsorship brings together a small cross-section of academics with conflicting interests and IP restrictions. It's fun working with enthusiastic students, even if we're talking about topics for purely intellectual reasons, but is there a better model to accelerate strategic R&D with rapid commercial payoffs to sponsors? I revisit this question later.

There are typically several other factors embedded within the R&D of publicly funded academia and government organisations that affect their IP rights and the IP rights of any partners (such as my employer). For example, many organisations choose to develop software on the GNU platform (http://www.gnu.org/), and are thus subject to the GNU General Public License, version 2 (GNU GPL v2: http://www.gnu.org/licenses/gpl-2.0.html). CSIRO develops various software on the GNU platform, with one consequence being that the software becomes public domain upon project delivery. So here we see a double IP challenge. Someone wishing to sponsor R&D with an organisation such as CSIRO will inevitably agree to grant various IP rights to CSIRO, and thus any commercial benefits of the partnership will at best (from the perspective of the sponsor) be shared. Alternatively, the sponsor may have no rights at all because, for example, the GNU GPL v2 demands there is no IP. So the sponsorship can be viewed as an altruistic exercise that accelerated the development of a new concept that benefits everyone, not only the sponsor. Please note I only use CSIRO as a representative example of most such organisations. CSIRO do outstanding work, and potential R&D partners should visit http://www.csiro.au/org/Partner.html for more information.

These simplistic and entirely non-exhaustive examples are nevertheless a useful introduction to the dilemma of sponsoring academia and government R&D. How can a sponsor pursue strategic R&D and gain IP rights to any commercial outcomes? In the case of academia, individuals (both faculty and students) can be paid to work within our company, variously via internships and paid projects. This assumes that appropriate personnel, resources and time are available; rarely at best. The competition for bright minds is fierce. And this leads to the key element of this article: Online 'data prediction competitions', a concept that could be extended to wider analytic and computational challenges.

As described at http://www.kaggle.com/pages/about, Kaggle is a platform for data prediction competitions that allows organisations to post their data and have it scrutinized by the world's 'best data scientists'. In exchange for a prize, winning competitors provide the algorithms that beat all other methods of solving a data crunching problem. Most data problems can be framed as a competition. Kaggle is thus an innovative solution for statistical/analytics outsourcing, and claim they are 'The leading platform for predictive modelling competitions'. Kaggle claim most organisations don't have access to the advanced machine learning and statistical



Schematic illustration of the Kaggle model for global online data prediction competitions. Is this a model for future alternatives to traditional consortia and government R&D partnerships?.

techniques that would allow them to extract maximum value from their data. Meanwhile, data scientists crave real-world data to develop and refine their techniques. Kaggle corrects this mismatch by offering companies 'A cost-effective way to harness the 'cognitive surplus' of the world's best data scientists':

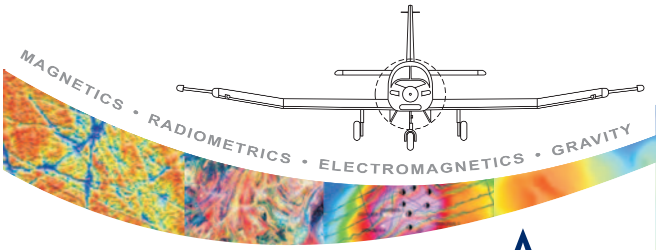
> *There are countless approaches to solving any predictive modelling problem. No single participant (or in-house expert, or consultant) can try them all. By exposing the problem to a large number of participants trying different techniques, competitions can very quickly advance the frontier of what's possible using a given dataset.*

A short video that explains how the Kaggle forum works, including a few examples and suggestions on how companies can protect their IP, can be found at http://host.kaggle.com/. Ongoing competitions are listed at http://www.kaggle.com/.

Is this the start of a new model for external R&D? As noted, the competition forum need not be the data mining challenges addressed by Kaggle. 'Any' R&D challenge could be posed to a global online network of scientists with 'cognitive surplus' (and financial deficit). The diversity of solutions that would be returned is an attractive consideration. To return to my opening theme about IP, Kaggle competition data is made anonymous, scrubbed of all personally identifiable information. It can also be masked, so that competitors can develop algorithms to predict results based on the presence or values of variables A, B and C without knowing what A, B and C actually are. This protects proprietary and competitive information, in addition to privacy. Kaggle also hosts private invitation-only challenges in which players undergo background checks and compete under non-disclosure agreements. Participants in private competitions are selected based on their past performance in Kaggle competitions. Every competitor that accepts the invitation to compete wins prize money, with larger prizes for those who produce the best results. Private competitions are an important tool for organisations that want to harness the power of predictive modelling competitions while keeping their data and IP private. In certain scenarios, the Kaggle-type forum may become an exciting and low-cost alternative to traditional R&D structures. Furthermore, the Kaggle-type platform enables many challenges to be tested that would simply not be addressed within the scope of R&D resources and timeframes possible within most companies.

Andrew Long
andrew.long@pgs.com

advanced airborne geophysics



T: +61 8 9479 4232
F: +61 8 9479 7361
W: aeroquestairborne.com
E: sales@aeroquestairborne.com.au

AEROQUEST
AIRBORNE

Alpha GeoScience

Geophysical instruments, contracting and consulting services

www.alpha-geo.com

Alpha Geoscience Pty. Ltd.
Unit 1/43 Stanley Street,
Peakhurst NSW 2210, Australia

Ph: **(02) 9584 7500**
Fax: (02) 9584 7599
info@alpha-geo.com

ARCHIMEDES FINANCIAL PLANNING

"Using a scientifically principled approach to improve financial buoyancy"

Noll Moriarty, M.Sc(Hons), CFP®

Specialising in detailed financial advice required by resources industry professionals

Website: **www.archimedesfinancial.com.au**
3 / 1315 Gympie Rd, Aspley, QLD. Phone 1300 387 351 or (07) 3863 1846
Authorised Representative of **Professional Investment Services** AFSL No. 234951 ABN 11 074 608 558

Baigent Geosciences Pty Ltd

Geophysical Data Processing Services

- Magnetics and Radiometrics
- Fixed wing and Helicopter Data
- Full 256 channel radiometric processing
- NASVD, MNF or NASVD with clustering
- Gradiometer Enhancement processing
- Independent Data Quality control

7 Owsten Court
Banjup WA 6164
Ph: +61 8 9397 1691
Email: mark@bgs.net.au
URL: www.bgs.net.au

Dr Peter Elliott

Ph.D, M.Sc, B.Sc(Hons), M.AusIMM

Elliott Geophysics International P/L

PO Box 1049
Cannington WA 6987
Australia

Ph/Fax + 61 8 9310 8669
Mob +61 (0) 418 872 631
Email elliottgeophysic@aol.com
www geophyicssurveys.com

Elliott
GEOPHYSICS

Geophysical Consultants to the Mining Industry in
Australia - Philippines - Indonesia - PNG - India - SE Asia

Flagstaff GeoConsultants

Integrated geophysical, geological and exploration consultancy services. World-wide experience.

Hugh Rutter	Geof Fethers	Gary Hooper
Michael Asten	Paul Hamlyn	
Jovan Silic	Ross Caughey	

Postmaster@flagstaff-geoconsultants.com.au
www.flagstaff-geoconsultants.com.au

Phone: 61 3 8420 6200
Fax: 61 3 8420 6299

Flagstaff GeoConsultants Pty Ltd (ABN 15 074 693 637)

A TOTAL EXPLORATION SERVICE

Geophysical Software Solutions Pty. Ltd

ABN 53 347 822 476

Software services for the geosciences

Developers of...

- ***Potent*** – *Versatile potential field modelling in a 3D environment*
- ***PotentQ*** – *Rapid interpretation of magnetic and gravity anomalies*
- ***EmQ*** – *Ultra-fast interactive EM modelling using moments*

Richard Almond
Director

Tel: +61 (2) 6241 2407
Fax: +61 (2) 6241 2420
E-mail: ralmond@geoss.com.au
Web: www.geoss.com.au

PO Box 31, Gungahlin,
ACT 2912, Australia
18 Bungaree Crescent,
Ngunnawal, ACT 2913

GEO SENSOR

SALES & RENTALS

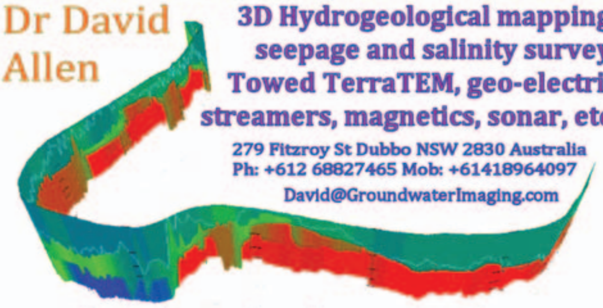
Ground & Airborne Instruments – Gravity, Magnetics, IP, Spectrometers & more.

P +61 (0)407 608 231 **W** www.geosensor.com.au

Garden City Office Park, Corporate House
Building 6, 2404 Logan Rd, Eight Mile Plains
Brisbane QLD Australia 4113

GROUNDWATER IMAGING

Dr David Allen



3D Hydrogeological mapping, seepage and salinity survey. Towed TerraTEM, geo-electric streamers, magnetics, sonar, etc.

279 Fitzroy St Dubbo NSW 2830 Australia
Ph: +612 68827465 Mob: +61418964097
David@GroundwaterImaging.com

www.GroundwaterImaging.com ABN: 65 120 800 179

OUTER RIM EXPLORATION SERVICES

Andrew Carpenter
General Manager

4 Uppill place, Wangara,

WA, 6065
P - + 61 (0)8 9408 0137
F - + 61 (0)8 9408 0688
M - + 61 (0) 458400138
andrew@outer-rim.com.au
www.outer-rim.com.au

ROCK PROPERTIES

MASS - Density, Porosity (permeability also avail.)
MAGNETIC - Susceptibility, Remanence; Aniso.
ELECTRICAL - Resistivity, Anisotropy; IP effect [galvanic]
ELECTROMAGNETIC – Conductivity, mag k [inductive]
SEISMIC - P, S Wave Velocities, Anisotropy
DIELECTRIC - Permittivity, Attenuation (by arrangement)
THERMAL - Diffusivity, Conductivity (by arrangement)
MECHANICAL - Rock Strength (by arrangement)

SYSTEMS EXPLORATION (NSW) PTY LTD

Contact - Don Emerson ***Geophysical Consultant***
Phone: (02) 4579 1183 **Fax: (02) 4579 1290**
(Box 6001, Dural Delivery Centre, NSW 2158)
email: systemsnsw@gmail.com

Subscribe now to our FREE email early alert or RSS feed for the latest articles from *Exploration Geophysics*.

www.publish.csiro.au/earlyalert

Calendar of Events 2012

January			**2012**
22–24 Jan	4th International Professional Geology Conference: Earth Science – Global Practice http://www.4ipgc.ca	Vancouver	Canada
February			**2012**
8–10 Feb	Workshop on EM in Hydrocarbon Exploration http://www.eage.org	Singapore	Singapore
16–18 Feb	SPG India, 9th International Conference & Exposition on Petroleum Exploration http://www.spgindia.org	Hyderabad	India
26–29 Feb	**22nd ASEG Conference and Exhibition 2012: Unearthing New Layers** **http://www/aseg2012.com.au**	**Brisbane**	**Australia**
March			**2012**
4–7 Mar	GEO 2012: 10th Middle East Geosciences Conference and Exhibition http://www.geo2012.com	Manama	Bahrain
7–9 Mar	First EAGE/ACGGP Latin American Geophysics Workshop http://www.eage.org	Cartagena	Colombia
22–23 Mar	3rd Unconventional Hydrocarbons Summit 2012 http://www.cdmc.org.cn/uhs2012	Beijing	China
25–29 Mar	SAGEEP 25: Making Waves – Geophysical Innovations for a Thirsty World http://www.eegs.org	Tucson	USA
April			**2012**
2–5 Apr	Saint Petersburg International Conference & Exhibition 2012 http://www.eage.org	Saint Petersburg	Russia
May			**2012**
14–18 May	GeoConvention 2012: Vision http://www.geoconvention.com	Calgary	Canada
27–29 May	3rd International Professional Conference: Geosciences and Environment	Belgrade	Serbia
29–31 May	3rd International Geosciences Student Conference http://www.agserbia.com		
June			**2012**
4–7 Jun	Copenhagen 2012: 74th EAGE Conference & Exhibition incorporating SPE EUROPEC 2012 http://www.eage.org	Copenhagen	Denmark
4–8 Jun	GPR 2012: 14th International Conference on Ground Penetrating Radar http://www.gpr2012.org	Shanghai	China
August			**2012**
5–10 Aug	34th International Geological Congress http://www.34igc.org	Brisbane	Australia
September			**2012**
3–5 Sep	Near Surface Geoscience 2012: 18th European Meeting of Environmental and Engineering Geophysics http://www.eage.org	Paris	France
November			**2012**
4–9 Nov	SEG International Exposition and 82nd Annual Meeting http://www.seg.org	Las Vegas	USA

Preview is published for the Australian Society of Exploration Geophysicists. It contains news of advances in geophysical techniques, news and comments on the exploration industry, easy-to-read reviews and case histories, opinions of members, book reviews, and matters of general interest.

Advertising and editorial content in *Preview* does not necessarily represent the views of the ASEG or publisher unless expressly stated. No responsibility is accepted for the accuracy of any of the opinions or information or claims contained in *Preview* and readers should rely on their own enquiries in making decisions affecting their own interests. Material published in *Preview* becomes the copyright of the ASEG.

Permission to reproduce text, photos and artwork must be obtained from the ASEG through the Editor. We reserve the right to edit all submissions. Reprints will not be provided, but authors can obtain, on request, a digital file of their article. Single copies of *Preview* can be purchased from the Publisher.

All editorial contributions should be submitted to the Editor by email at preview@mayes.com.au. For style considerations, please refer to the For Authors section of the *Preview* website at: www.publish.csiro.au/journals/pv.

Preview is published bi-monthly in February, April, June, August, October and December. The deadline for submission of material to the Editor is usually before the 15th of the month prior to the issue date. The deadline for the February 2012 issue is 9 January 2012. For the advertising copy deadline please contact Wendy Wild on (03) 9662 7606 or wendy.wild@csiro.au.