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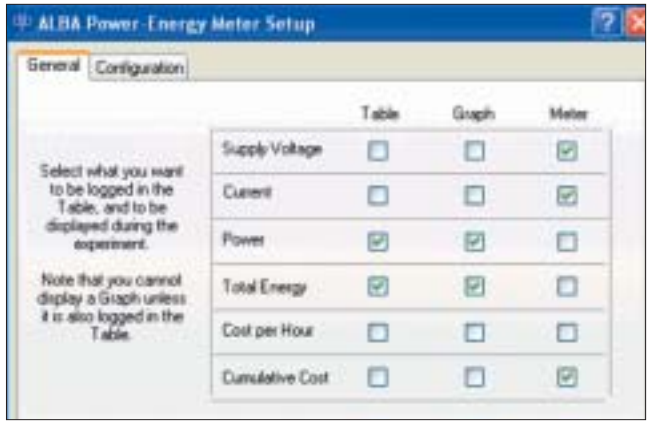
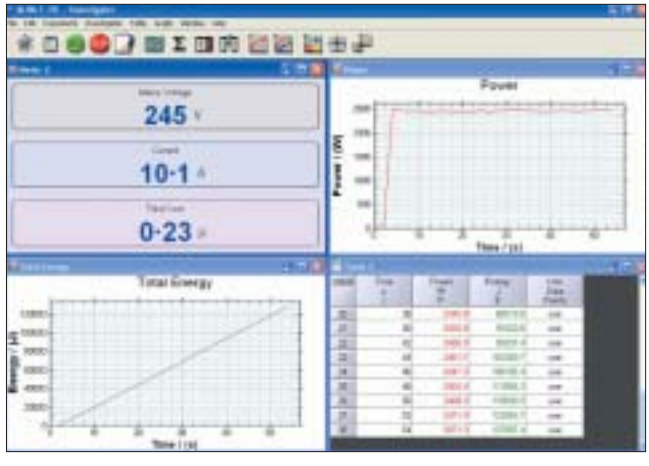
RESOURCE REVIEW

Meter offers dual-mode displays to demonstrate relationships





Clockwise from top left: **Figure 1.** *The djb microtech Power-Energy-Cost Meter in use with both a kettle and a laptop computer.* **Figure 2.** *The various display options that are available.* **Figure 3.** *The display while a kettle of water is being boiled.* **Figure 4.** *The meter in standalone mode.*

The Power-Energy-Cost meter (figure 1) is the latest addition to djb microtech's ALBA system, for which the company is well known. The device has two modes of usage: standalone, using its own LCD display (figure 4), and connected to a computer to provide a selection of screen displays. There is a range of choices of what to display (figure 2), and one or more can be chosen, depending on what you wish to observe and compare.

Sampling times can be selected from 2, 10, 30 and 60 s. The cost per kilowatt hour is input as appropriate.

I suspect that many teachers will use the meter in its computer display mode, probably connected to a digital projector. In this way, students will be able to see how, with a device like a kettle, for example, the power level, RMS mains voltage and current remain near enough constant while the kettle remains on, whereas the total energy and total cost rise linearly (figure 3).

When using standalone mode you are limited to an LCD display (figure 4). This can be scrolled to display, in order, RMS voltage, current and power; cost/hour and

unit cost; and energy and time elapsed. While in standalone mode the display is updated every 5 s.

By connecting a multipoint into the unit's socket, a range of devices can be examined, switching them in and out of use, but their total current rating must not exceed 13 A. The unit/kilowatt hour cost can be changed in either mode.

I found the device easy to install, and it automatically recognized the serial port connection (an adapter for a USB connector is also available, if required). I used the software successfully on both Windows 98 and Windows XP.

The Power-Energy-Cost Meter is an excellent device that can very easily be used to demonstrate the relationship between power, voltage and current; and between energy, power and time. It also shows much more energy is transferred by a kettle than by a 40 W light bulb; how ordinary filament and energy-saving bulbs compare; and the fact that mains voltage does indeed fluctuate a little.

Chris A Butlin

Power-Energy-Cost Meter

djb microtech ltd

Rating: ★★★★ very good

Price: Power-Energy- Cost Meter complete with connecting serial cable and associated software: A1-1005.05 £141 (+ VAT). USB/serial converter (if required): S3-1010.00 £20.00 (+ VAT). Post and packaging UK £6.90 (overseas: enquire of supplier).

System requirements: Microsoft Windows 98, 98SE, ME, NT4 with SP6, 2000 or XP.

Supplier: djb microtech ltd, Delfie House, 1 Delfie Drive, Greenock, Renfrewshire, Scotland PA16 9EN (tel: (0)1475 786540; e-mail: info@djb.co.uk; Web: www.djb.co.uk).

BOOK REVIEW

Every picture tells a story...

In his book *Imagined Worlds*, Freeman Dyson writes: 'There are two kinds of scientific revolutions, those driven by new tools and those driven by new concepts...The effect of a concept-driven revolution is to explain old things in new ways. The effect of a tool-driven revolution is to discover that new things have to be explained.'

In *Visual Explanations* and *The Scientific Image: from Cave to Computer* you see the role and power of visual explanation in each of these types of scientific revolution.

Edward Tufte, a professor at Yale University, has written several acclaimed books about ways of presenting information. In *Visual Explanations* he uses a fascinating range of illustrations to explore representations of motion, of process and dynamics, of causes and effects, of explanations and narrative. He considers general principles for representing information graphically as well as design strategies, especially the arrangement of images as narrative.

A few examples that Tufte discusses are data related to the decision to launch the Space Shuttle *Challenger* in 1986; the corruption of Newton's diagrams of his optics experiment showing dispersion of white light and second refraction of a coloured ray; a remarkable 1975 graphic showing the development of rock-and-roll; and Wegener's 1915 maps, which demonstrate the concept of continental drift. This is a wonderful book to browse and learn from.

Harry Robin, described as a former director of the Acoustic Department at the Juilliard School of Music, is clearly fascinated by the history of science. His

book shows dozens of illustrations used in explanations, the majority of which (but not all of them) are scientific.

The illustrations are grouped into a number of sections, such as 'Observations' (e.g. Galileo's drawings of phases of the Moon, 1616), 'Induction' (e.g. Descartes' explanation of the colours of a rainbow, 1637), 'Methodology' (e.g. Fraunhaufer's painting of the solar spectrum, 1820) and 'Classification' (e.g. astronomical images in the tomb of Pharoah Seti I, *c*.1290 BC). Each of the illustrations is accompanied by a commentary that offers an explanation of the image and its context.

In school textbooks, illustrations are more often than not used to supplement the text and to make the pages more attractive. By contrast, many of the images in this book provide the main statement and it is the text that is supplementary. However, the contention of this book is stronger yet: the author aims to convince the reader that we cannot think without images. This is another book to browse with pleasure.

Peter Campbell

Visual Explanations

Edward E Tufte

Rating: ★★★★ very good

Price: $45

Details: Published 1997, Graphics Press, Cheshire, CT, ISBN 0 9613921 2 6

The Scientific Image: from Cave to Computer

Harry Robin

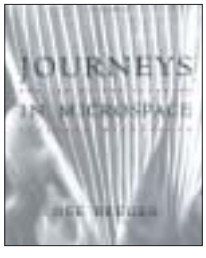
Rating: ★★★★ very good

Price: £24.99

Details: Published 1993, W H Freeman, New York, 240pp (pbk) ISBN 0 7167 2504 5

BOOK REVIEW

...and small really is beautiful



As *Journeys in Microspace: the Art of the Scanning Electron Microscope* and *Heaven and Earth: Unseen by the Naked Eye* demonstrate, scientific images can stimulate not just the intellect but also our sense of beauty and mystery. The scientific images that these books present are as awe-inspiring as any art image.

Dee Breger works at Columbia University as a scientist but she also describes herself as a 'micrographic artist'. She begins in *Journeys in Microspace: the Art of the Scanning Electron Microscope* by describing, for the non-scientist reader, scanning electron microscope (SEM) techniques, their range of magnifications (×100 to ×300 000) and their many uses.

There are some nice touches. To give a sense of scales, for example, she writes: 'If Manhattan were condensed so that the distance between the Hudson and the East River was the width if your thumbnail, the SEM could study the city brick by brick.'

The book contains almost 200 images, of which 28 are enhanced with false colour. Breger has chosen images that emphasize the complexity and beauty of minute forms in nature, such as details at the edge of a butterfly's wing, various kinds of diatom, surface detail on tungsten wire and tree rings from a conifer.

Heaven and Earth: Unseen by the Naked Eye is a magnificent book full of surprising and memorable images. An introductory essay by David Malin, who is best known for his accomplished astronomical photography, makes the link between human senses and consciousness. As he points out, complex information is conveyed incredibly quickly through vision. We easily observe

nuances of colour, size, shape, texture, brightness and contrast.

This volume shows how the range of objects perceived by the eye can now be extended, from the very small to the very large, using a variety of microscopes and telescopes. Images are grouped into different length scales, each group introduced by a times (logarithmic) scale graphic so that the reader can appreciate their range of sizes. The authors begin with bubble chamber trails, go on up in scale to objects such as a blood clot, olive leaf scales and snowflakes, and conclude with galaxies and the Hubble deep field. A short and interesting caption describes each image.

As a result of the book being produced by an art publisher, the quality of the paper and the 368 images is superb. The images cover such an astonishing variety of objects that the reader is bound to be captivated and feel connected to unseen worlds. I should love to have 40 images from this book printed at poster size, so that I could display a different one in my classroom each week of the school year. They would make excellent discussion and research starters.

Peter Campbell

Journeys in Microspace: the Art of the Scanning Electron Microscope

Dee Breger

Rating: ★★★★ very good

Price: $52.50

Details: Published 1995, Columbia University Press, New York, 201pp (hbk) ISBN: 0 231 08252 5

Heaven and Earth: Unseen by the Naked Eye

Katherine Roucoux and David Malin

Rating: ★★★★ very good

Price: £9.95

Details: Published 2002, Phaidon, London, 400pp (pbk) ISBN 0 7148 4439 X

BOOK REVIEW

It's in the eye of the beholder

Graham Farmelo opens this collection by drawing comparisons between poetry and science equations. He is impressed by the remarkable fact that laws of nature can be expressed so conveniently as equations. A popular reaction is: 'Is God a mathematician?' Farmelo refers to Einstein and Dirac, and their strong belief that the fundamental equations of physics must be beautiful. So, what does 'beauty' in this sense mean to a scientist at the frontiers of discovery and invention?

The 11 essays encompass many kinds of 20th-century science: astronomy, quantum-field theory, environmental chemistry, information theory, evolutionary biology and general relativity. Authors include Robert May, Frank Wilczek, Roger Penrose and Steven Weinberg. Most both tell the story of the scientists involved and also explain the science expressed in their chosen equation.

All share a common preoccupation with the key role of mathematics. For example, Wilczek uses a quote by Heinrich Hertz on Maxwell's equations: 'One cannot escape the feeling that these mathematical formulae have an independent existence and an intelligence of their own, that they are wiser than we are, wiser even than their discoverers, that we get more out of them than was originally put into them.'

Weinberg, in the concluding essay, describes the equations of modern physics as great cultural products and predicts that they 'may outlast even the beautiful cathedrals of early ages'.

You can read and meditate on the essays

in any order. At about 20 pages, each essay is short enough to manage at a weekend. The only problem, of course, is finding enough free time for such an idle pursuit on a weekend during term time. Keen physics students may do better on this score than their teachers.

Peter Campbell

It must be Beautiful: Great Equations of Modern Science

Graham Farmelo (ed)

Rating: ★★★★ very good

Price: £20

Details: Published 2002, Granta Books, London, 224pp (hbk) ISBN 1 8620 74798

BOOK REVIEW

Revision aid is full of questions

Owen Bishop's latest publication is packed with useful information, problems, worked examples and full answers. My first impression was that I was reading a textbook but, when I turned to the preface, I discovered that it is intended as a revision text for students of AS and A2 electronics, as well as other level 3 courses, which will include several BTEC specifications (i.e. applicable to courses for 16+ year olds).

Bishop seems to have succeeded in covering the content of the various advanced courses, but students or teachers of vocational courses would be advised to check their specification. The last six chapters cover various 'systems': power supply, power switching, analogue control, audio and communication. There is also a chapter on digital control, which includes a brief overview of microprocessor and microcontroller systems.

The author also offers advice on revision methods, and there is a great deal of emphasis on exam preparation. The style is by necessity concise and we must assume that student would be able to refer to other sources for further explanation. The contents are logically organized and easy to follow, and there is a good index.

I found a few topics confusing, but only because the author offers a unique approach so on occasion I would have liked more explanation. This might deter weaker candidates. For example, he reminded me of the advantages of the superposition theorem when analysing circuit networks. Unfortunately the WJEC and other specifications require students to use Thevenin's Theorem. The examples may confuse them unless they've been taught the method.

A plus for this book is that it is packed with questions. Each chapter has 'ten quick questions' and lots of longer ones. The structure is designed to encourage good revision methods. Answers are given to all questions, with detailed explanation for the longer ones. There are no (obvious) past paper questions but most teachers supply these anyway.

Users of Bishop's previous texts will probably not hesitate to use this one. Others would be well recommended to consider it as a useful addition to their lab's electronics library. I will certainly find it a useful addition. At £14.99 some students might consider it a bit expensive for a revision book; I think it's worth it.

David Grace

Essential Electronics

Owen Bishop

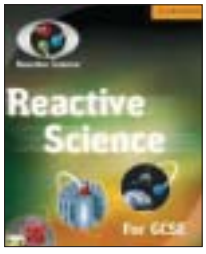
Rating: ★★★★ very good

Price: £14.99

Details: Published 2004, John Murray, London, 180pp ISBN 0 7195 8056 0

BOOK REVIEW

Book offers homework exercises



At 500-plus pages, *Reactive Science for GCSE* is hefty. It is specifically written for use with the AQA double-award specification and covers the two-year course at both the foundation and the higher tiers. The content required for the higher tier only is clearly signposted as such. The chapters are numbered in accordance with the modular specification.

The book states: 'Much of the material in this book was previously published as the Science Foundations series', so previous purchasers of these texts will know the format. The double-page spread approach is not used – indeed, the format is fairly novel. The left half of most pages is mainly text; the right side diagrams. Following a short paragraph on each subtopic are a large number of questions, making the book ideal for homework.

The questions vary across a range of difficulty and the answers are available on one of two CDs that are available to complement the book. Unfortunately the publisher's website advises that this CD will not be available until February 2005. There is no price indication for the activities CD (containing the answers), but as a guide the Interactive Glossary and Statements Map CD (available from September 2004) costs £80. Sections particularly suited to the Ideas and Evidence requirements of the National Curriculum are highlighted in the contents.

I disagree with a number of diagrams – most notably in the use of arrows for electron flow on the wire in the chapter on electricity rather than conventional current, and angles measured between light rays and the mirror (rather than the normal) in the chapter on waves.

Having said that, I believe that the standard of the book overall is very good in terms of serving as a hybrid textbook/workbook. Given the scope of its coverage, I would consider it a very worthwhile investment, especially for schools or individuals following the AQA specification.

Tony Reeves

Reactive Science for GCSE

Jean Martin and Bryan Miller

Rating: ★★★★ very good

Price: £16.99

Details: Published 2004, Cambridge University Press, ISBN 0 521 60920 8

PLACES TO VISIT

Are you going to San Francisco? There's certainly plenty to see

In 1915, San Francisco invited the world to celebrate the opening of the Panama Canal with a world's fair, known as the Panama Pacific International Exposition. It was also a celebration of the city's recovery from the 1906 earthquake and fire.

The Exploratorium, which could be called the big daddy of all of these hands-on types of museum, is housed in the last remnant of the exposition – the Palace of Fine Arts. The overall impression is big – a big building, with big exhibits and plenty of them. The range of exhibits is such that most age groups are entertained (there's even an area for toddlers and a café), and you could easily take 100 pupils or more.

The exhibits include sections on pendulums; heat and temperature; sound and

hearing; motion; electricity and magnetism; seeing; complexity; and life sciences. Recently there was also a very interesting display covering science-based art. There wasn't much in the way of chemistry, but biology was well covered and the rest of the exhibits were physics related.

Many of the exhibits allow you to learn by doing, with the minimum of reading beforehand; this surely is what these places are all about and the Exploratorium does it very well.

The shop had some interesting items at reasonable prices (you can even buy books to tell you how to build some of the exhibits), although there was little that isn't available elsewhere. (In some ways that seemed good because it suggests that the world of physics is moving forward as one.)

The quarterly *Exploratorium Magazine* and the book entitled *Exploratorium Cookbook I* were both first published nearly 20 years ago. The museum's teaching staff, eager to share their ideas with other educators, created the *Exploratorium Science Snackbook* in 1991.

I didn't see any exhibits that were broken, even though it was the end of the day when I visited. Another great idea is that you can see the workshops where the exhibits are made and usually talk to the people making them.

Of course it wasn't all perfect – the overall look of the place was gloomy, but that never put my colleague, David, off. He reckons that he's generally quite susceptible to surroundings, adding that he thought that the quality of the exhibits made up for it. While some of the exhibits look good in blackout, others in the shadows would look better if well lit. Likewise, much of the equipment looks worn (an indication of success, but it doesn't help the feel of the place). In contrast, Techniquest in Cardiff benefits from bright lighting and an airy feel.

Overall the Exploratorium is a great place to visit and it'll cater for the masses.

Hands on: exhibits at the Exploratorium.

The Exploratorium

Rating: ★★★★ very good

Price: $3 to $5 per child depending on date. Free adult per 10 children. Free admission on first Wednesday of each month. Due to capacity limits, groups of 10 or more are required to make reservations or will not be admitted.

Details: See www.exploratorium.edu/visit/fieldtrips.html for very detailed information. The Exploratorium, 3601 Lyon Street, San Francisco, CA 94123 (415) EXP-LORE (e-mail: reservations@exploratorium.edu; Web: www.exploratorium.edu/).

The California Academy of Sciences Web: www.calacademy.org/. Search for astrobiology: life in the extreme.

Audium Web: www.audium.org/. Visit the site for a better understanding of this attraction to do with sound.

The San Francisco Cable Cars Web: www.sfcablecar.com/. The site has an interactive page that explains how the cable cars work.

If you're planning a visit to San Francisco with a group, it's a must see (make sure that you check their website for special events first), and the Golden Gate bridge isn't far away. In the city there's the Californian Academy of Science (mostly biology, but there's a fantastic exhibit on extraterrestrial life, and there are plans afoot for a new planetarium when the academy moves back to its original site near the Exploratorium), and with the cable cars and their museum, and the Audium (an exhibition to do with sound) there's more than enough to fill a day.

David Smith and Gary Williams

WEB WATCH

Science inspires some great art

Figure 1. *Kaleidoscopes combine science and art.*

Figure 2. *Neo-Escher images from silicon mirror.*

Physics, with its mastery of optics, space and therefore everything in the realm of visual art, should mean that science and art are close cousins. Art–science connections are very 'in', and this, if nothing else, is worth pointing out to any reluctant physics students who think that physics is universally despised (except by physics teachers). There is even a contemporary art space called The Physics Room in Christchurch, New Zealand, so-called because originally the space was an old science block. However, the artists liked the ideas of experimentation that the name suggests.

'Physics + art' gets more than 3 million hits on Google, so you're never going to have time to explore all aspects of the alliance. As a teacher I am looking for ways to engage my students with the drab, non-arty curriculum by introducing exciting and different images and contexts with which to motivate and inspire them.

Light and sound

Interdisciplinary investigations of light and sound can easily be both scientific and artistic. For example, see digitalcommons.hil.unb.ca/dissertations/AAIMQ30021/ and www.blakeschool.org/academics/middle/davinci/page3.html.

In a busy science curriculum we might be keener to provide offshoots that reinforce the subject matter. Where better to start than reflection? Kaleidoscopes offer fascination, beauty and art, and the following site is a good starting point kaleidoscopeheaven.org/ (figure 1).

A virtual kaleidoscope can be made using the 'silicon mirror' download from www.torpor.com/, which allows you to make your own patterns. Libby Reid is an artist who has used the mirror to create neo-Escher pictures (figure 2).

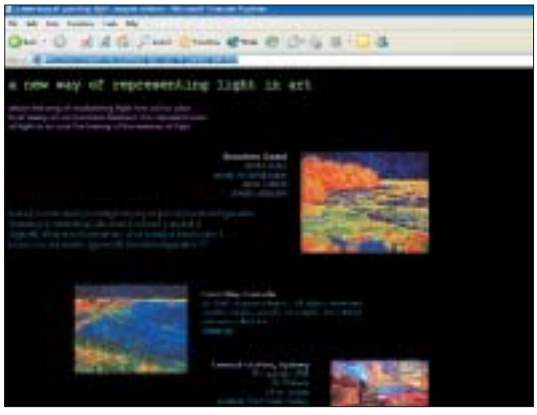


Figure 3. *Wayne Roberts experiments with light.*

Figure 4. *Space is the inspiration for much art.*

This site has some good links to others that deal with making and using kaleidoscopes, as well as many kaleidoscope images. Particularly intriguing is the Disgustoscope, which uses mirrors to make symmetrical images from body parts: www.eskimo.com/~billb/amateur/dscope.html.

On the subject of symmetry, I enjoyed making a snowflake at snowflakes.lookandfeel.com/. I found this site in a curious mixture of weblinks listed in an Art-Science-Math website, which is at www.princetonol.com/groups/iad/lessons/middle/mathsci.htm.

Links range from biology/ecology sites through computer art and Brian Evans' website at www.lightspace.com/ through to science photography and NASA's always-reliable astronomy picture-of-the-day at antwrp.gsfc.nasa.gov/apod/astropix.html. Evans' art involves using computers to make a visual representation of music. Students might like to explore the effects that they can produce using Windows Media Player and changing the visualization of the sounds that they are playing.

There are zillions more art-science connections to explore. For example, Australian artist Wayne Roberts at www.wroberts.com.au/html/a_new_way_of_painting_light.html has used the amplitude of light to modulate the wavelength characteristics (i.e. colours) that he uses (figure 3).

Space stuff

Space inspires many artists. There are the illustrators who do the artist's impressions that we often see to imagine the view, say, on Mars, based on current understanding; then there are all possible artistic extrapolations in every direction from this. Many have a close link to sci-fi/fantasy art. Some are intriguing, some informative, and some tasteless trash (but they may appeal to adolescents). Many of these images are great as a trigger for discussion. Make your own mind up by using www.spaceart.org/ as a starting point (figure 4).

Chaos and fractals

Kids delight in the unexpected, and they love drawing the different patterns of the butterfly by using the website at www.exploratorium.edu/complexity/java/lorenz.html (figure 5).

Fractals are another phenomenon that sits at the interface of maths, physics and art. Although you can draw them mathematically, I much prefer the 'live' fractals that you can make (with practice) using video feedback. There are some great examples of this technique, with full instructions for how to make your own images, at www.videofeedback.dk/

Figure 5. *Introduce chaos with the Lorenz butterfly.*

Figure 6. *Peter Henry King's amazing fractals.*

World/. There are also some real gems from Peter Henry King at www.sweetandfizzy.com/fractals/index.html (figure 6).

I was only sad to find that I had missed out on a total video-feedback waterbed experience. This was an interactive art exhibit from Jaron Lanier in New York a few years ago. 'You climb steps onto a long platform. Through a curtain you enter a darkened chamber. The floor is a luminous, transparent waterbed radiant with images. You lie on the bed, look up and see yourself, for the ceiling is a large mirror. As you move your body you distort the patterns of light in the bed by changing the shape of the body of water, which is in the path of a video feedback loop.' You can find out how to recreate this experience at www.well.com/user/jaron/waterbed.html.

Chladni

There are so many beautiful shapes and patterns in physics that it isn't surprising that artists 'discover' them all the time. The subtle curves and geometric shapes of Chladni figures are yet another excuse to enjoy being creative. For example, www.scienceart.nl/Experiments%20vervolg/Vervolg%20pags/Mainfr%20VervolgExper-03.htm has some lovely images to inspire you and your students. Connoisseurs of the technique swear by bowing the plates with a well rosined violin bow rather than using a central vibrator because this gives more control.

The basic method is described, complete with a nice applet, at www.phy.davidson.edu/StuHome/jimn/chladni/pages/menu.htm.

Optical illusions

Optical illusions may not be art, but they must be pretty close sometimes, and they certainly fascinate kids. Edward Adler's light illusions at web.mit.edu/persci/people/adelson/checkershadow_illusion.html are a great starting point, and there are some wonderful interactive illusions provided by the San Francisco Exploratorium at www.exploratorium.edu/exhibits/f_exhibits.html.

A fascinating guide to optical illusions in art (Escher, Dali and the optical art of Bridget Riley, etc) can be found on the website at eluzions.com/Illusions/Art/Optical/, together with lots of other great links explaining optical illusions.

For something completely different, The Science and the Artist's Book is an exhibition by the Smithsonian Institution Libraries and the Washington Project for the Arts. You can discover more at the website: www.sil.si.edu/Exhibitions/Science-and-the-Artists-Book/phys.htm.

Kerry Parker