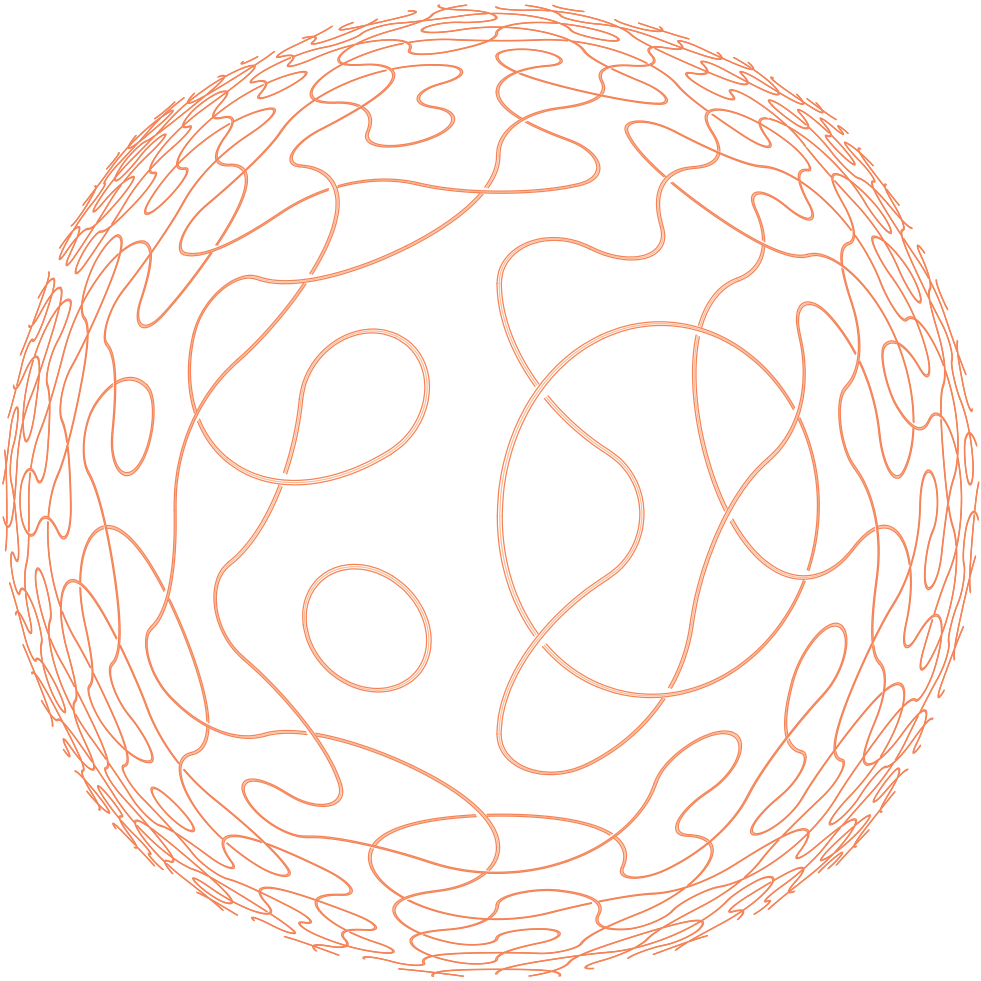
litmuspaper
Daily news from The Times Cheltenham Science Festival
Thursday 14 June 2012

News stories from the festival day 2
Science visualisations
Rudy Rucker on 'hacking code'

Beginnings and endings



DAY 2: INTERVIEW

Anatomist and broadcaster Alice Roberts is Professor of Public Engagement in Science at the University of Birmingham. We discussed her event 'Evolution: The Human Story'.

How can fossils of our ancestors inform us about humans today?
One of the best lines of evidence about our ancestry comes from fossil remains. Because they are fossils, it is mostly hard tissue. To really understand what they are telling us we have to understand the anatomy of living animals today, then try to reconstruct the entire bodies.

How do you draw conclusions about an entire species from a single fossil specimen?
Understanding variation in past species is difficult because we've got such limited material to work with, [but this] doesn't mean we cannot get useful knowledge from it. There was a lot of debate about the hobbit, this tiny species from Indonesia. When it was first discovered a few people said 'we think this is a pathological specimen', because one explanation perhaps, for a tiny person with a small brain, could be that they suffered from a kind of disease. But I think it is clear from looking at the skeleton more carefully, that if it's a disease it's a disease that does not just make the brain smaller, but seems to affect the body in such a way that makes Homo florisiensis, the hobbit, look like some of our earlier ancestors. We have to bear it in mind, but it would have to be an extraordinary disease to do that!

You mentioned the possibility of the permafrost retreating and revealing more specimens, particularly Neanderthals. Would that be a big deal for science?
It would be an absolutely massive deal to have a frozen Neanderthal! We'd be able to see what these people looked like, what they were eating. Presumably, alongside a mummified body you're going to find a lot more organic remains of culture as well. Look at Otzi [an iceman discovered a few years ago] it's not just his body we're interested in, but all the organic stuff that was with him. He's carrying a means to make fire, medicinal herbs, he's got a beautiful grass cape on, fur boots, all of those things we can't even imagine looking at the bones.

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Understanding matter

The Large Hadron Collider (LHC) at the European Organisation for Nuclear Research (CERN) is a giant particle accelerator researchers are using to re-create the conditions just after the Big Bang – the moment scientists believe our universe was created. Many of us have heard of the LHC, but what does it actually do?

The accelerator is a huge circular track 100 metres below the earth's surface. Scientists at CERN take particles smaller than atoms, whizz them along this track at a great speed and crash them into each other. When the particles collide they produce lots more even tinier particles, which are measured by detectors in the collider.

Vast computing power is required to collect this data, eventually culminating in an image like this, which shows what particles were made and how they moved after the collision. Scientists use this data to deduce how these tiny particles work in this high-energy state, and to learn what happened just after the universe was created.

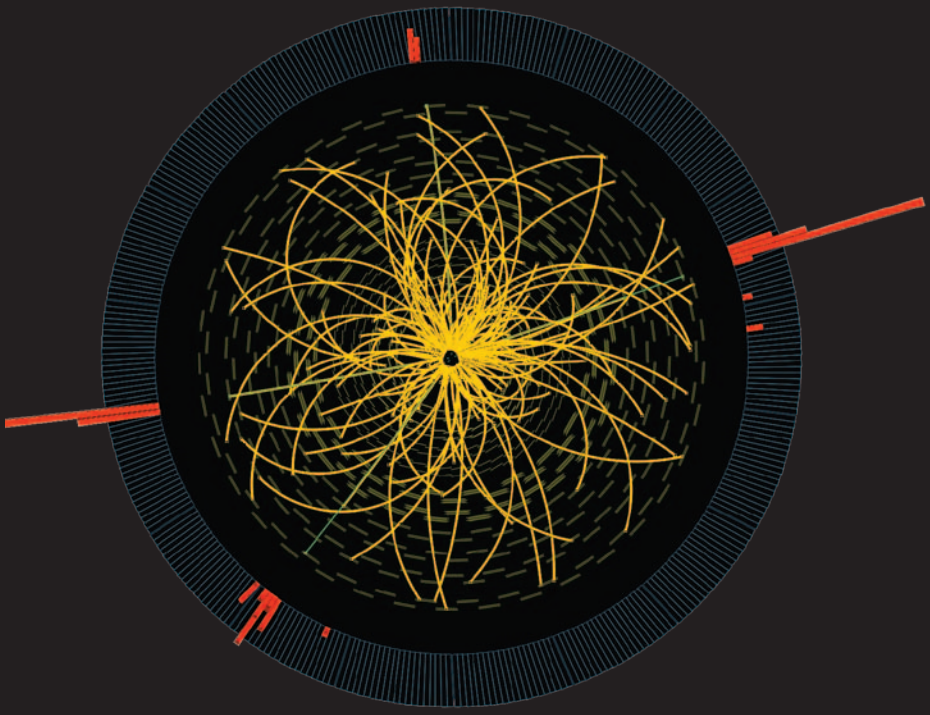


Image: CERN

The LHC took ten years to build, between 1998 and 2008. At a cost of around £6 billion, it is the most expensive scientific instrument ever built. However, it aims to answer fundamental questions about physics and the technology used to build it has produced many patents.

The overall goal of the LHC is to find the elusive Higgs Boson – an excitation in the Higgs Field which fills all of space. The Higgs field and the Higgs Boson are theoretical ideas predicted by the Standard Model of particle physics, which all physicists base their predictions on.

Scientists hope to find the Higgs Boson using the tiny clues that each of the high-energy collisions in the LHC provide. Data contained in pictures like these might one day lead to the discovery of that elusive particle, which might tell us more about the origins of our universe.

Family planning: the key to curb population growth?

The root of the debate about the world's rapidly expanding population lay with one question; will the growing global population solve itself?

The unanimous decision from the audience at *Population: how many is too many?* was 'yes'.

Less developed countries are the worst affected by population growth. Accessibility of family planning to women in these countries is a major issue. Population and Sustainability Network Coordinator Karen Newman strongly reinforced the point that women worldwide have the right to choose when they have children, and that the use of family planning would help in their decisions.

Environmentalist Jonathon Porritt raised the unnerving statistic that an extra half a child per family would see the global population rate significantly accelerate. He said that if the average number of children in every family worldwide was 1.9, in 50 years time the population would reach 9 billion. If that figure increased to 2.6, the population in the same time scale would reach 10.5 billion.

Should Britain be a fan of wind energy?

Politics will play an important role in resolving the issue of green energy production in Britain, agreed speakers at *Wind Power: The great debate*. They were debating the motion 'This house believes that Britain should be a fan of wind energy'. A majority voted in favour.

With atmospheric carbon dioxide levels at a historic high (over 400 parts per million two weeks ago), environmentalist Jonathan Porrit explained to the audience that decarbonising our energy sources is now non-negotiable: 'People talk about what it all costs. We need to ask how much will it cost *not* to do it?'.

Speakers at the event argued that the national grid in Britain will need to change and adapt to match new energy sources and technologies. Current polices in Europe focus on changing behaviour to reduce energy consumption. They said that wind power is not a panacea, it is just part of the solution using a combination of energy resources.

Nuclear power was a surprisingly popular solution with nearly half the audience in favour. It would seem that we will need to address our energy needs in a number of ways.

Keeping warm and keeping on

According to *Scrapheap challenge* presenter and eco-enthusiast Robert Llewellyn, the exhaust gases from a typical household boiler could be used to drive mini-turbines that can generate 2500 kWh of energy in a year. 'And believe me, 2500 kWh makes a big difference to your electricity bills', he said, noting that a typical house uses up about 3300 units a year in heating. 'But there will come a point when your boiler won't work – unless you fart into it', he said. 'With fossil fuels running out, we need to think about whether we can transport ourselves around and live in this civilised world without destroying each other and the planet'.

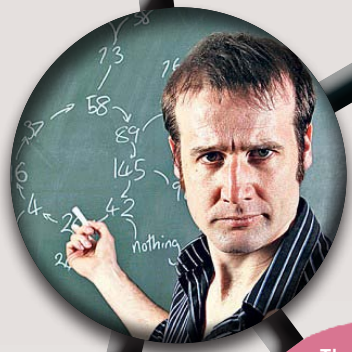
Both Llewellyn and engineering expert Roger Kemp agree that it is possible, but difficult to meet the challenge. They said that disjointed policy approaches, more families living in rented housing and fear of long term investment were major hurdles. 'Most houses that will exist in 2050 have already been built', added Kemp, saying that many of these are ill-suited to insulation. There is no 'one size fits all model' which we can employ to address the problems.

Helen Arney's protocol for writing an indie song

0.00: Girl meets boy/ Boy meets girl
0.15: Ride Skateboard
0.29: Steal Laura Marling's fans »
» 0.57: Rock it with a mini-harmonica
1.14: Repeat phrase until it sounds meaningful
1.37: End on a minor chord

'3435 is the only munchausen number, ($3^3 + 4^4 + 3^3 + 5^5 = 3435$) but it only works in base 10 and because it is base-dependent. Those sorts of relationships, they burn bright but fast.'

18% phone battery **Steve Mould** thinks you could save if you change the background of your phone to black



'371 is a narcissistic number. If you raise each number to the number of digits there are ($3^3 + 7^3 + 1^3$) that equals 371.'

The perfect numbers are 6, 28, 496, (both former favourites of **Matt Parker**), 8128, and **33,550,336** 'But that's a bit big for a number – I am a size-ist.'

'The **Euclidian Rubber glove** might also improve your life. This a molecule which is assymetric, but can be turned inside out and into a different molecule.'

'Socks wear out in asymmetric places. The 'euclidian rubber glove' technique for socks (ie. regularly turning them inside out) could make them last twice as long.'

The power of three

Stand-up mathematician Matt Parker, musician Helen Arney and demo whizz Steve Mould are successful science communicators in their own right. Together, they form The Festival of The Spoken Nerd, (FOTSN for short), a scientific solution of comedy, songs, demos and puns. This blend has proved incredibly popular.

Since their humble beginnings performing in a crowded room above a pub, FOTSN have graduated to ever bigger venues, including the Bloomsbury Theatre, Shakespeare's Globe, and their interactive Re:generation Gameshow here at The Times Cheltenham Science Festival today. We tried to identify their molecular make-up.

Sci-type specimens

Physicist and oceanographer Helen Czerski assesses the value of recognizable faces in science communication

'Celebrity' is a funny word. Originally it meant someone who was famous or celebrated, perhaps for starting a revolution, writing the first dictionary or discovering the South Sandwich Islands. These days the word is associated more with an extravagantly hedonistic lifestyle, having a handbag to put your dog in and being followed around by paparazzi. Then there is the phrase 'celebrity scientist'. What does this mean? And do we need or want it?

I care a lot about sharing science with the public, about sharing my enthusiasm for it and showing how many fascinating nuggets of science we see around us daily. What is more important is the habit of critical thinking, of asking 'why?', and of weighing up the evidence for different answers. I think it is obvious that we need enthusiastic, fun and knowledgeable people to share all this. But society needs something more.

Humans remember information best when it comes along in the form of a story. And stories need characters. Celebrity scientists can act as those characters, so they can help communicate stories about science. I think of 'celebrity' scientists as what biologists call 'type specimens'. A type specimen is an example that anchors a definition. It is not the only one of its kind but it provides an example to refer to. When we think of a geologist, we might think of Ian Stewart; a geneticist? Adam Rutherford; an anatomist? Alice Roberts. And... go on then... a physicist? Brian Cox.

If you listen to how people talk you notice that they commonly describe things in terms of other things. A capybara looks like a cross between a guinea pig and a hippopotamus. The South American drink mate tastes like a cross between tea and coffee. Humans use cultural references to communicate effectively, so if science wants to be memorable it needs familiar faces for society to refer to.

I dislike the term 'celebrity scientist'. But I do think that these representatives of science play an important role in making science accessible

We know that science is a huge collective effort; the well-known faces of science are just visible examples. They represent the enthusiasm, knowledge and personality of thousands of individual researchers and they have the communication skills to convey all that and make the science fun and interesting. It is important that they are representative – for example, we need more women out there talking about their science.

I do not think it necessary for the public faces of science to get out their Hollywood sunglasses and start making handprints in the concrete pavement outside their department. I dislike the phrase 'celebrity scientist'. But I do think that these representatives of science play an important role in making science accessible. Let's celebrate that!

Helen Czerski is presenting 'Orbit: Earth's Extraordinary Journey' today at the festival.

Visualise this

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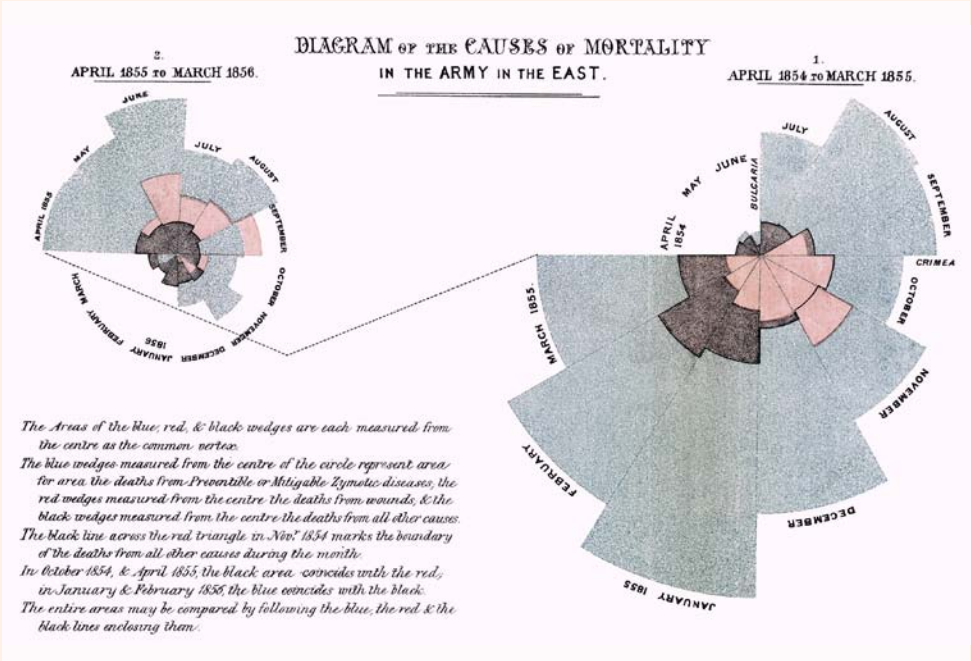
Scientists suffering from data overload use visuals to make sense of their statistics. But do infographics give the full picture? The British Library Science Team investigate.



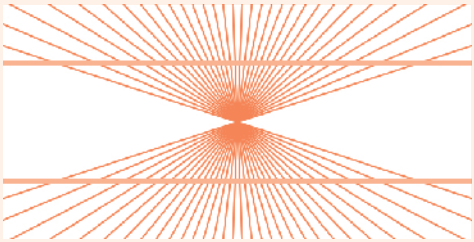
It is said that a picture is worth a thousand words. Diagrams and data visualisations are fundamental to the ability of scientists to understand the world and communicate their findings. Often visually compelling and straddling the interface of science and graphic design, some can be considered works of art in their own right. In an era where researchers find themselves suffering from information overload, visualisation is essential to their ability to consolidate, manipulate and make sense of data.

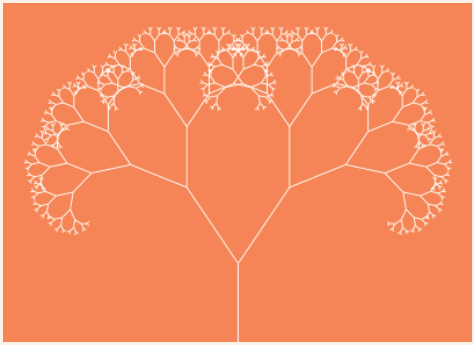
Along with this data deluge/tsunami/flood (pick your analogy) has come a proliferation of visualisations and infographics. This has been partly enabled by 'Open Data' initiatives like data.gov.uk, which push large datasets into the public domain, as well as technological advances that have democratised the analysis of 'big data' from something only done by

computer scientists to something well within the reach of your average scientist or citizen scientist. Open source tools, such as Processing and Gephi, allow researchers to create dynamic and visually engaging diagrams and animations with only a little bit of training.

At The Times Cheltenham Science Festival, chances are that you will see some pretty whizzy graphics (anybody at **Eyes, Lies and Illusions** on Tuesday? **Space:3D** on Saturday?). What is interesting about many diagrams is both what they show, as well as what they do not show. As humans, when trying to make sense of large things beyond our grasp, we tend to simplify, rationalise; detail is lost; and so too it is with information graphics. Their beauty may be enticing, but on occasion, is also deceiving.

The British Library is home to some classic examples of data visualisation, such as Florence Nightingale's *Rose Diagram* (left), as well as a plethora of contemporary resources. We now provide access to datasets through our catalogue and are enabling researchers through DataCite to get credit for datasets they make available in national data centres. Through our collections, services and events, we are keen to support contemporary researchers and all those who are engaged with the visual communication of science. Watch this space!

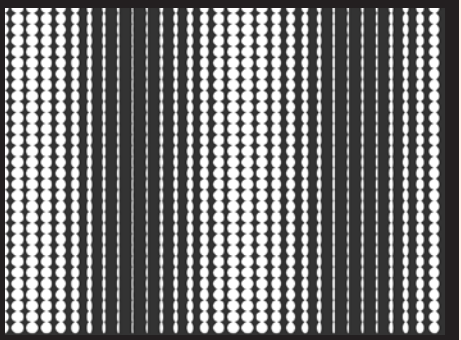




```
int Nx = 20; //number of shapes across
int Ny = 20; //number of shapes down
int dispWidth = 500;
int dispHeight = 500;

size(dispWidth,dispHeight);
background(51);
ellipseMode(CENTER);
stroke(255);
smooth();

//draw the shapes
rectMode(CENTER);
for (int j=0;j<height;j=j+dispWidth/
Nx){
for (int i=0;i<width;i=i+dispWidth/Ny){
 ellipse (i, j, 0.95*(dispWidth/
Nx)*(1.2+cos(i*2*PI/width))/2,
0.95*(dispWidth/Ny));
}
}
```



Left: Florence Nightingale *Diagram of the causes of mortality in the Army in the East* (1858). This seminal diagram showed that the vast majority of deaths were from preventable diseases (blue) in comparison with wounds (red), or other non-preventable causes (black).
Right top: The Hering illusion discovered by Ewald Hering in 1861
Right centre: Basic L-system example coded through Processing;
Right below: Processing code using trigonometric functions to create optical art style image, by Phillip Kent (www.openprocessing.org/sketch/59331)

Hacking code

Mathematician, computer scientist, science fiction author and philosopher Rudy Rucker explains how computer programming turns the computer into a window on the universe

Hacking is like building a scale-model cathedral out of toothpicks, except that if one toothpick is out of place the whole cathedral will disappear. And then you have to feel around for the invisible cathedral, trying to figure out which toothpick is wrong. Debuggers make it a little easier, but not much, since a truly screwed-up cutting-edge program is entirely capable of screwing up the debugger as well, so that then it's like you're feeling around for the missing toothpick with a stroke-crippled claw-hand. But, ah, the dark dream beauty of the hacker grind against the hidden wall that only you can see, the wall that only you wail at, you the programmer, with the brand new tools that you make up as you go along, your special new toothpick lathes and jigs and your realtime scrimshaw shaver, you alone in the dark with your wonderful tools. (Rudy Rucker, *The Hacker and the Ants)*

On a good day, I think of hacking as a tactile experience, like reaching into a tub of clay and kneading and forming the material into the shapes of my desires.

A computer program is a virtual machine that you build by hand. Hacking is like building a car by building all of the parts in the car individually. The good thing is that you have full control, the bad thing is that the process can take so much longer than you expect it to. Are you sure you feel like stamping out a triple-Z O-ring gasket? And synthesizing the plastic from which to make the gasket? The hacker says, 'Yaar! Sounds like fun!'

Of course it does get easier as you build more and more. Often as not, you can re-use old pieces of code that you hacked for other projects. A hacker develops a nice virtual garage of "machine parts" that he or she can reuse. As a beginner, you start out using prefab parts made by others, but sooner or later, you're likely to grit on down to the lowest machine levels to see just how those parts really work.

To be a writer you need something you want to write about; to be a hacker you need something to hack about. You need to have an obsession, a vision that you want to turn into a novel, or into a virtual machine. It's going to take you so long to finish that you will need a fanatic's obsession to see a big project through. Essential in either case is the simple act of not giving up, of going back into it over and over again.

I think the most interesting things to hack are programs which turn the computer into a window to a different reality. Programs which express true computer nature. Chaos, fractals, Artificial Life, cellular automata, genetic algorithms, Virtual Reality, hyperspace – these are lovely areas that the computer can see into.

I once heard a hacker compare his computer to Leuwenhoek's microscope, so strong was his feeling that he was peering into new worlds. In an odd way, the most

interesting worlds can be found when this new 'microscope' looks at itself, perhaps entering a chaotic feedback loop that can close in on some strange attractor.

There are, of course, ignoramuses who think hacking is about grubbing scraps of information about war and money. What a joke. Hacking is for delving into the hidden machinery of the universe.

The universe? Didn't I just say that the coolest hacks are in some sense centered on an investigation of what the computer itself can do? Yes, but the computer is a model of the universe.

The universe is like a parallel computer, a computer with no master program, a computer filled with self-modifying code and autonomous processes – a space of computation.

Sometimes disturbed individuals think the universe is a computer – in a bad kind of way. Like that everything is gray and controlled, and distant numbers are being read off in a monotone, and somewhere a supervisor is tabulating your ever-more-incriminating list of sins.

But in reality, the universe is like a parallel computer, a computer with no master program, a computer filled with self-modifying code and autonomous processes – a space of computation, if you will. A good hack can capture this on a simple color monitor. The self-mirroring screen becomes an image of the world at large. As above, so below.

The correspondence between computers and reality changes the way you understand the world. If you know about fractals, then clouds and plants don't look the same. Once you've seen chaotic vibrations on a screen, you recognize them in the waving of tree branches and in the wandering of the media's eye. Cellular automata show how social movements can emerge from individual interactions. Virtual reality instructs you in the beauty of a swooping flock of birds. Artificial Life and genetic algorithms show how intelligent processes can self-organize amidst brute thickets of random events. Hyperspace programs let you finally see into the fourth dimension and to recognize that kinky inside-out reversals are part and parcel of your potentially infinite brain.

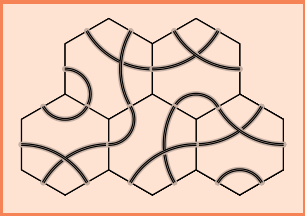
Hacking teaches that the secret of the universe need not be so very complex, provided that the secret is set down in a big enough space of computation equipped with feedback and parallelism. Feedback means having a program take its last output as its new input. Parallelism means letting the same program run at many different sites. The universe's physics is the same program running in parallel everywhere, repeatedly updating itself on the basis of its current computation. Your own psychology is a parallel process endlessly revising itself.

Hacking is a yoga, but not an easy one. How do you start? Taking a course on one of the "object-oriented" programming languages Java or C++ the probably the best way to start; or you might independently buy a C++ compiler and work through the manual's examples. And then find a problem that is your own, something you really want to see, whether it's chaos or whether it's just a tic-tac-toe program. And then start trying to make your vision come to life. The computer will help to show you the way, especially if you pay close attention to your error messages, use the help files – and read the ****in' manual. It's a harsh yoga; it's a path to mastery.

Rudy Rucker is author of The Ware Tetralogy, 'Infinity and the Mind', 'The Fourth Dimension' and 'Mind Tools'.

Today's cover by Phillip Kent

The sinuous curves forming threads and knots are a response to the idea of 'beginnings and endings'. But in fact the whole image is generated from something much simpler: a single hexagonal tile design that is repeatedly copied and tiled to fill two-dimensional space. The neat thing about this tile is that it can be rotated to any of six positions which all inter-connect. By manipulating the orientation of each tile, using randomness or regularity, rich patterns can be generated. (By the way, the same tiling was used to generate the 'neurons' in yesterday's cover.)



One final piece of mathematics: the tiling is passed through a transformation function which shrinks the whole of two-dimensional space into a circular disk. The apparent three-dimensionality of the image is an artefact of how the brain reads that compression of space. Mathematically, this image is totally flat!

To explore the tiling and transformation processes in detail for yourself, take a look at the interactive version of the cover at design-science.org.uk/litmus-paper. You can run the code interactively and explore some different options, and download the source code to your own computer to work on. You are also invited to contribute any code that you modify/create to our social coding website.

phillip.kent@gmail.com

Today's free activities

DISCOVER ZONE

Town Hall, 10am – 5pm

For all ages, the Discover Zone is open every day of the Festival, and gives kids the perfect opportunity to get hands-on with interactive technology and experiments.

cheltenhamfestivals.com/discoverzone

SAFRAN Messier-Bugatti-Dowty

GE imagination at work

BBC SCIENCE ZONE

BBC SCIENCE ZONE

Imperial Gardens, All day

For all ages, the BBC Science Zone gives you the opportunity to meet the production teams and presenters responsible for some of your favourite BBC science programmes, explore the content further and get hands-on with science.

For the full programme visit cheltenhamfestivals.com/bbc-science-zone

EDF ENERGY ZONE

Imperial Gardens, 11am – 6pm

Come to the EDF Energy Zone to visit the fascinating interactive exhibits exploring the world of energy generation including models of the latest nuclear reactors.

EDF ENERGY

GE PAVILION

Imperial Gardens, 11am – 6pm

The GE team are offering lots of things to do and see for all ages including a Caterham Formula 1 racing car, the hugely popular flight demonstrator, a model of the first jet engine and much more!

GE imagination at work

SCIENCE QUESTION TIME

The Times Eureka Tent, 5pm

With Gill Samuels, David Willetts, Mark Henderson, Russell Foster and Tom Whipple. Explore today's biggest debates, newest discoveries and favourite Festival moments with a selection of the day's speakers, *The Times* journalists and the Festival team.

THE TIMES