The 2002 book, *Biomimicry*, describes a new science that studies nature's best ideas and then imitates these designs and processes to provide innovative and sustainable solutions for industry and research development. Author and international expert, **Janine Benyus**, is now focusing on working with industry and governments across the globe to implement her ideas. She will be touring Australia with the team from The Natural Edge Project in May.

Peter Nguyen

Innovation inspired by nature

Biomimicry

Janine Benyus believes that by treating nature as 'model, measure and mentor', Australian companies, governments and universities are in a strong position to take advantage of the leading edge opportunities provided by the emerging field of what she has coined 'biomimicry'.

The idea is that, during its 3.8 billion years of research and development, nature has evolved highly efficient systems and processes that can inform solutions to many of the waste, resource efficiency and management problems that we now grapple with today.

Biomimicry has already provided some timely, standout innovations in areas such energy engineering, and waste reuse, where multiple-scale efficiency improvements are greatly needed. 'Over the millions of years, nature's life forms through natural selection have had to live with the constraints of the entropy law on a solar budget,' reflects Wes Jackson, noted author and President of The Land Institute, Kansas, US, a body that promotes natural agricultural systems. Biomimicry's application is predicted across many sectors as the great potential for improved performance is realised.

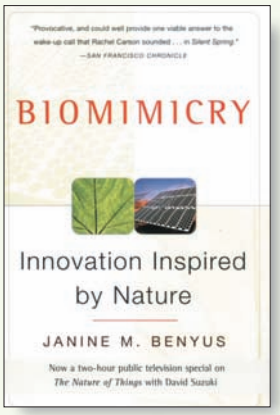
Benyus's book[1] sets out that there are nine basic laws underpinning the concept of biomimicry:

1. Nature runs on sunlight
2. Nature uses only the energy it needs
3. Nature fits form to function
4. Nature recycles everything
5. Nature rewards cooperation
6. Nature banks on diversity
7. Nature demands local expertise
8. Nature curbs excesses from within
9. Nature taps the power of limits.

As a biologist, the question for Benyus is not whether our technology is natural, but how well adapted it is to life on Earth over the long term. She says that engineers, scientists, architects and designers are often humbled, and then excited, when they discover how nature already has solutions to their challenges, and how it generally outperforms their traditional solutions, showing them creative alternatives. 'Nature knows what works, what is appropriate, and what lasts here on Earth.'

As co-founder of the Biomimicry Guild, Benyus has assisted the engineering, architectural and scientific professions as well as major international corporations, such as carpet company Interface, global architects HOK, Proctor & Gamble and Nike, to learn from nature's designs how to develop truly sustainable solutions.

Bill Valentine, HOK's President said



working with Benyus had been a pivotal event for his organisation. 'We were immersed in a sea of information, strategies, science and insight and left with a strong commitment for a far wider discovery and education of these ideas across the firm.'

In order to meet the needs of businesses striving for sustainability, the team from the Biomimicry Guild focus on cultivating the transfer and application of biological knowledge to the business community, evolving the best model for integrating this knowledge with business, and creating strategies for monitoring successful

1 Benyus JM (2002). *Biomimicry: Innovation Inspired by Nature.* Perennial, New York.

Progress

'Janine Benyus is without question the world's most imaginative person in the field of environmental development and restoration. Time spent with Janine is a transmission of hope about what we can learn from and be within nature.'

Paul Hawken, Natural Capital Institute

progress. An educator at heart, she believes that the better people understand the genius of the natural world, the more they will want to protect it.

Many biomimicry success stories exist across a number of technological fronts where they are providing new and sustainable solutions. Examples of these are the invention of Velcro fastening from studying cockleburs, the design of the Japanese Shinkansen bullet train nosecone, based on the beak of a kingfisher bird, the ventilated design of Harare's Eastgate Complex and the design of gecko tape which mimics the surface of gecko lizards' feet (see box).

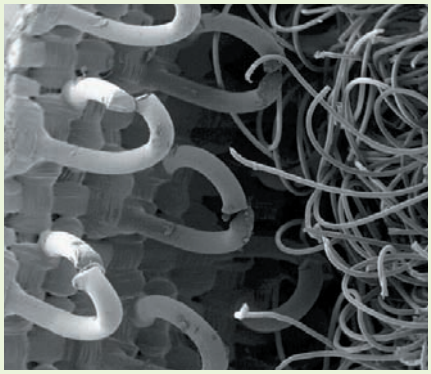
According to Jonathon Porritt, of the UK sustainability charity, Forum for the Future, *Biomimicry* is 'one of those rare hopeful notes in the modern chorus of environmental warnings. Benyus offers a radical alternative to today's industrial model of progress – an elegant survival strategy drawn from a better understanding of those natural systems on which we are still totally dependent. Perhaps the best thing about this quest for innovation inspired by nature is that it is more than just a theory. It is already underway.'

- **Karlson 'Charlie' Hargroves and Michael H Smith**, The Natural Edge Project.

Janine Benyus will be delivering the Keynote at the joint dinner for the Australian Business Leaders Forum for Sustainable Development and the Queensland EPA Sustainable Industries Award in Melbourne on 15 May and will then set off on a two-week tour of the country engaging with various companies, government agencies, organisations and institutions in partnership with The Natural Edge Project. For enquires about Janine Benyus' tour and engagements visit ***www.naturaledgeproject.net/BenyusTour06.aspx****.*

Biomimicry applied

Termite mounds are marvellously engineered for internal temperature consistency. Janine Bolliger



A scanning electron microscope image of Velcro's hooks and loops (370 micron view). Phillips Exeter Academy

The hydrophobic surface structure of the lotus leaf became the inspiration for a new kind of self-cleaning paint. Feng Yu

Passive cooling in buildings

The Eastgate Complex, located in Harare, Zimbabwe, is a 324 000 square-foot commercial office and shopping complex which includes two nine-storey office buildings and a glazed atrium. In Zimbabwe's extremely hot climate, the building's primary cooling method is natural ventilation. Engineers from firm Arup, led by Mick Pearce, sought inspiration for the ventilation design from termite mounds since termites require their home to remain at an exact temperature of 87°F (30.5°C) throughout a 24-hour daily temperature range of between 35°F at night and 104°F during the day (1.6°C to 40°C).[1] The solution was a passive-cooling structure with specially designed hooded windows, variable thickness walls and light coloured paints to reduce heat absorption.

Velcro

In the 1940s, Swiss inventor George de Mestral found that, upon returning home for a walk with his dog one day, his pants and the canine's fur were covered with cockleburs. He studied the burs under a microscope, observing their natural hook-like shape, which ultimately led to the design of the popular adhesive material, Velcro. Velcro is a two-sided fastener – one side with stiff 'hooks' like the burrs and the other side with the soft 'loops' like the fabric of his pants. The result was VELCRO® brand hook and loop fasteners, named for the French words 'velour' and 'crochet'.[2]

Self-cleaning paints

Germany company, Sto AG, have developed a biomimicry inspired exterior coating with a water-repellant surface based on that of the lotus leaf. Professor Wilhem Barthlott, from the University of Bonn in Germany, developed the surface after looking for environmentally benign alternatives to toxic cleaning detergents in order to reduce environmental impacts. He asked the question 'How does nature clean surfaces?' It became obvious that nature doesn't use detergents at all – instead it designs self-cleaning surfaces with hydrophobic properties.[3]

1 Summary of learning points taken from Rocky Mountain Institute's *Green Developments 2.0* CD-Rom (companion to Wilson A, Seal JL, McManigal LA, Lovins LH, Cureton M and Browning WD (1998). *Green Development: Integrating Ecology and Real Estate*. John Wiley & Sons, New York). Case study also available from Hargroves K and Smith MH (2005). Chapter 18: Greening the built environment. In *The Natural Advantage of Nations: Business Opportunities, Innovation and Governance in the 21st Century.* pp. 368–370. Earthscan, London.

2 Velcro Industries, N.V. www.velcro.com.

The design features of Japan's Shinkansen 500-Series exemplifies biomimicry in action. Its overhead pantograph sports serrations were modeled on the design of owl plumage to reduce air resistance noise, and the air piercing nose cone design was inspired by the kingfisher's beak. From the Swiss–Japan Assoc. for Engineers and Scientists.

Transport aerodynamics

The 500-Series Shinkansen Japanese bullet train running between Tokyo and Hakata is one of the fastest trains in the world. The challenge for the design of the Shinkansen was to make it run quietly at high speed. Learning that the owl family is the most silent and stealthy fliers of all birds, the Shinkansen design team discovered the bird's secret in its wing plumage design – many small saw-toothed feathers protrude from the outer rim of their primary feathers.

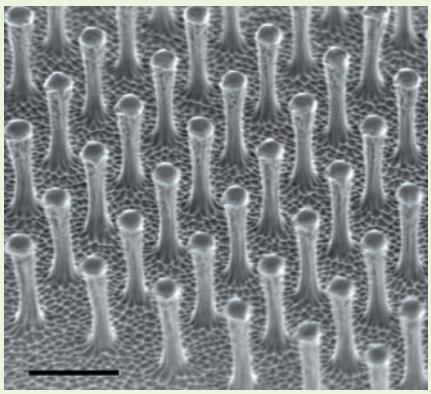
Geckos' feet pads have given up their secret.
Chartchai Meesangnin

Other birds do not have these feathers. These saw-toothed wave feathers are called 'serration feathers' and they generate small vortexes in the airflow that then break up the larger vortexes that produce noise. It took four years of strenuous effort by the younger engineers on the team to practically apply this principle. Finally, 'serrations' were inscribed on main part of the pantograph (the collectors that receive electricity from the overhead wires), and this succeeded in reducing noise enough to meet the world's strictest standards. This technology is now called a 'vortex generator', and it has already been applied to aircraft and is now being applied to the caps and boots of professional skaters.

Another problem to be overcome was the low-level sonic booms occurring from tunnel exiting. Again, looking to nature for a solution to the sudden changes in air resistance, the design team discovered that the kingfisher bird's specially designed beak enables it to dive from air to water (low- to high-resistance mediums respectively) with minimal energy loss. Computer modeling techniques used to determine what style of nose for the Shinkansen revealed the kingfisher beak to be the most ideal shape.[1] Note that the lights on the front of the train mimic the nostrils of the bird.

Gecko tape

Scientists at the University of Manchester have developed a new type of adhesive, which mimics the mechanism employed by the gecko lizard to walk on surfaces, including glass ceilings. The new adhesive ('gecko tape') contains billions of tiny plastic fibres, less than a micrometer in diameter, which are similar to natural hairs covering the soles of gecko's feet which generate elecrodynamic adhesion at a microscopic level.[2,3] One square centimetre of gecko tape could support a weight of one kilogram. In addition to a general adhesive, it can be used to move computer chips in a vacuum and pick up small fibres. The tape can be used several times over and does not use toxic chemicals found in common adhesives.[4]



A scanning electron micrograph of micro-fabricated polyimide hairs like those employed on gecko tape. Scale bar is 2 µm.
Courtesty AM Geim.

1 Japan For Sustainability, Biomimicry, Series No 6, 'Shinkansen technology learned from an owl? – The story of Eiji Nakatsu' (hwww.japanfs.org/en/newsletter/200503.html#3).
2 Article sourced from the University of Manchester News Centre, Spiderman becomes a reality at the University of Manchester.
3 Technical paper on gecko tape: Geim AK et al (2003). Microfabricated adhesive mimicking gecko foot hair. www.newscientist.com/article.ns?id=dn3785
4 ibid.