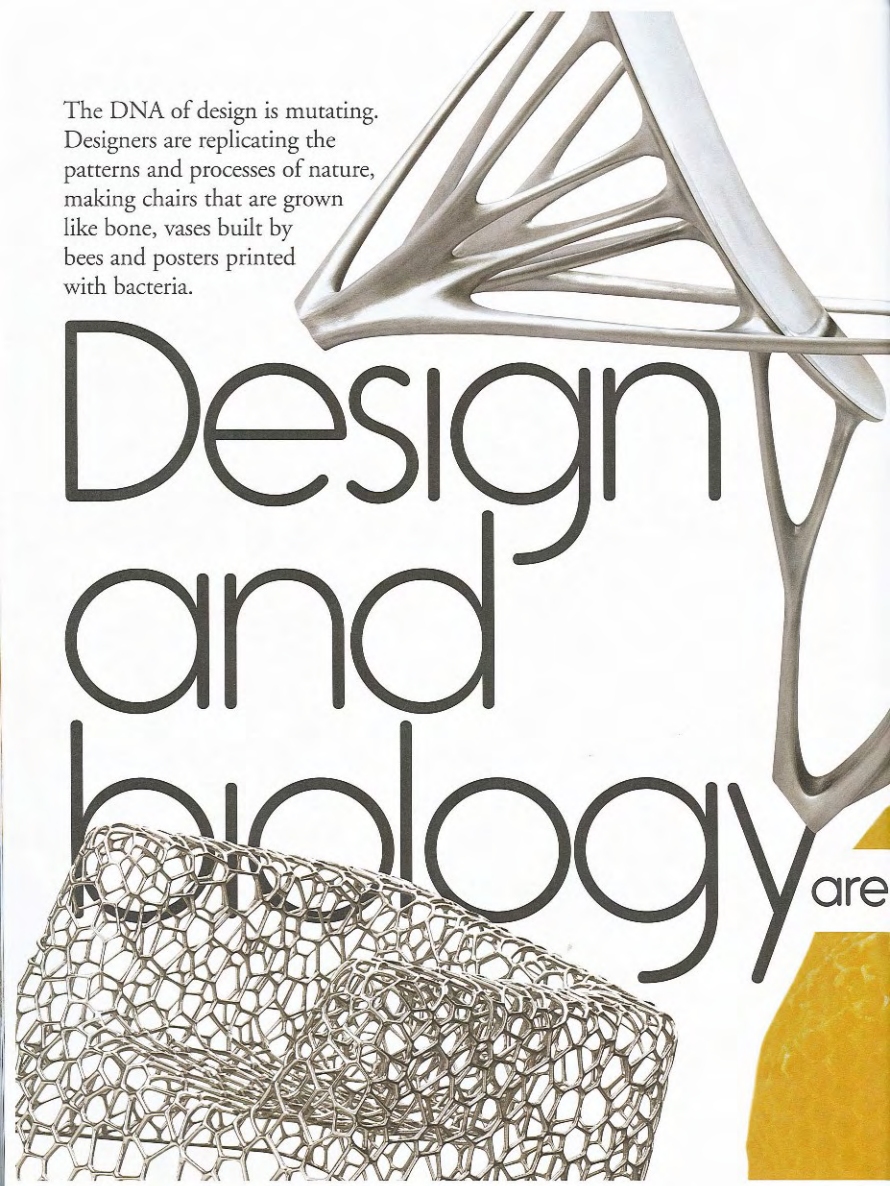
The DNA of design is mutating. Designers are replicating the patterns and processes of nature, making chairs that are grown like bone, vases built by bees and posters printed with bacteria.

Design and biology are



WORDS **DANIEL WEST**

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Designers and inventors have been influenced by nature for centuries. Leonardo da Vinci's design for a flying machine was essentially a mechanical bird, while a more recent invention, velcro, mimics the hook-like burrs of burdock seeds. However, most contemporary "natural" design is only natural in a formal sense, using organic shapes. True biodesign is more fundamental than aesthetic facsimile – it's about recreating biological growth processes.

"Industrial design is experiencing a paradigm shift: not mimicking the forms of nature, but mimicking the processes themselves. It's a movement affecting both biomedicine and the manufacture of furniture," says Mory Gharib, a professor in bioengineering at the California Institute of Technology (Caltech) in the US.

Cell structures, nature's essential building blocks, are one focus of designers' investigations. Marc Newson's Random Pak chair uses a structural pattern similar to the way cells organise themselves in the human body. "The structure is like cells pushed together. As they collide they produce planes in different directions," says David Mansueto, a designer in Newson's studio. These planes, which are effectively the edges of the cells meeting, create the complex structure of the chair. "That's what we keep," says Mansueto, adding, "It's the first time it's been used to make furniture."

Designs like this are possible now because software has become advanced enough to replicate natural growth patterns, while manufacturing techniques like rapid prototyping allow designers to create almost any shape much faster than traditional processes allowed. Random Pak's distinctive aggregated bubble shape resulted from over a year of prototyping and computer modelling. "Rapid prototyping was the only way to produce Random Pak: you couldn't cast it or carve it," says Mansueto.

While Newson's design focuses on a universal pattern of nature, Dutch designer Joris Laarman is looking at a more specific process, designing chairs that mimic the way that bones grow. His Bone chairs are designed by removing all non-stress-bearing material, which is one of the ways bones achieve their optimal shape. Laarman actually used software designed by car manufacturer Opel to reduce the weight of car components – software itself derived from the field of bionics, which translates natural processes into engineering.

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PHOTO: DANIEL WOOD

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crude chair shape. The computer then calculated where stresses would occur with the weight of a sitter. Non-stress-bearing material was removed, leaving a skeletal structure where each strut was precisely positioned and shaped according to the weight it would support. In the human body, cells called osteoclasts work the same way by removing excess bone to leave an efficient skeletal shape.

Simultaneously, weak points were detected and bolstered with extra material, which is an inherent property of tree growth. "When you snap a twig, it breaks at a weak point. Trees sense these weak points and strengthen them accordingly," says Laarman. In other words,

Laarman's chair combines elements of bone and tree growth, applying evolutionary intelligence to an industrial product. "One part provides the structure, and the other optimises it. That's where the evolution comes in," he says.

This process can be applied to any substance: the computer adjusts the width and position of struts according to the strength and density of the raw material. Laarman made a slender seat from aluminium, and a thicker chaise longue from rubber. However, instead of rapid prototyping the chairs themselves, Laarman rapid prototyped the moulds. By rapid prototyping with ceramic material – in contrast to the usual plastic resin – molten aluminium could be cast into the sinuous algorithmic vacuums defined by the software.

Rather than merely borrowing its growth patterns, some industrial designers are actually growing the bone itself. Tobie Kerridge grew human bone into wedding rings for a Royal College of Art research project. Samples of wisdom teeth were taken from willing couples, and the cells were grown in a petri dish over a miniature circular scaffold. The bone was then shaped and impregnated with resin by jewellery designer Nikki Stott, before being placed in a protective ring of metal. The final designs were achieved in collaboration with the people whose teeth had been used.

The scaffold itself was formed from a ceramic material called bioglass, and constructed by researchers at London's Kings College. "It looked a bit bubbly, which was the ideal structure for growing into," says Kerridge. "It was also bioinductive, which means the organic bone and synthetic glass combined into a hybrid material."

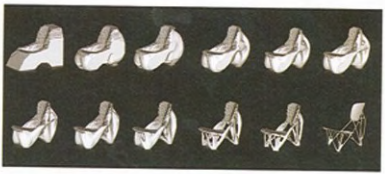
The use of human bone raised ethical issues uncommon to industrial materials. Legislation had to be written to protect the patients and the hospital. "The whole thing overran by a year largely due to ethics," says Kerridge. "It would have been easier if we'd gone private, but that would have had an air of exclusivity."

Natural growth processes have also crept into graphic design. Dutch student Jelte van Abbema made his own ink out of E coli bacteria and used it to design his Design Academy Eindhoven graduation project. Printed onto a paper of agar and cellulose, the ink revealed the letters as it grew. The posters were placed into advertising boards with temperature and humidity controlled to ensure growth. "It was like a huge petri dish," says van Abbema. "In the evening I had no image and in the morning I had my presentation." Obviously, there are risks involved, since E coli can cause meningitis, pneumonia and septicaemia.

Van Abbema's process leaves some of the designing to the bacteria, submitting his letters to the randomness of nature. Another Eindhoven graduate, Tomás Libertíny, employed a more extreme process, getting insects to build his graduation project. Libertíny made a vase-shaped hive that a swarm of bees thickened with wax on both the inside and outside. The wax sheets used to shape the hive (as found in domestic candle-making kits) were printed with honeycomb to help the bees build in the right place. Libertíny overlapped the hexagonal grids to improve the vase's rigidity. "It was like a floor plan for a building," he says.

Putting sugar at the top of the hive meant that the swarm didn't have to look for food, but even then the final vase took a week to build. "The bees were irritated by monitoring as you're opening up their home," he says. It was impossible to check daily, so he had to estimate the right time to take out the vase. Too early and it would be incomplete, too late and the vase would be filled in. He calls his method "slow prototyping".

German-Swedish design duo Kram &



This page: Various stages of Joris Laarman's design process for the Bone chair. After computer modelling, Laarman rapid prototyped a ceramic mould, in which he cast the aluminium. The mould and any excess aluminium were chipped away with chisels. The chair is hand-polished to achieve a more refined finish. (opposite page)

DANIEL NICOLAS