WHEN SCIENCE AND DESIGN COLLIDES

Words Veronica Simpson

Bold new materials, structures and manufacturing processes are being conjured in laboratories between biologists, chemical engineers and designers. Is this a cause for celebration or for concern?

It is early 2011 and students on Central Saint Martins' MA in textile futures have spent three days in the stuffy upper floors of one of the old, cellular college buildings – pre the art school's amalgamation into one giant shed at King's Cross – trying to create photovoltaic cells from food. The lab is a mess of blueberries, sliced bread and jelly, but Professor Carole Collet, who started up the textile futures course a decade earlier, is calmly presiding over the final stages of her students' attempts to achieve electricity through food. She knows that this exercise – better than any lecture – will help drum into her students that 'energy is not free. It actually has to be generated in some way and it has a cost to the planet'. Thus she hopes to instil a respect for the impact of design (especially textiles, that most wasteful and polluting of all design disciplines) on our ecosystem, along with a passion for collaborating with scientists in order to evolve more enlightened materials, processes and products.

The world of scientifically informed, experimental design – crossing science with making and thinking – was pretty far out three years ago. All of a sudden it has become, if not mainstream, at least a very tangible presence in the minds of a growing body of designers, artists, scientists, educators, manufacturers and policymakers – as well as the students who are snapping up courses in this exciting and expanding field. UK Chancellor, George Osborne, has even declared synthetic biology – a synthesis of biology, chemical engineering and design – 'the future, the antidote to famine and global warming'; which will certainly help free up some funding for experiments with snail shells and E. coli bacteria.

Collet's graduates – whose work regularly wins both arts and science prizes – are now dispersed across a wide range of roles that straddle laboratory and design studio. Of the most recent crop, Natsai Chieza, who initially trained as an architect, is now experimenting with pigment-producing bacteria as research assistant at CSM as well as University College London. Meanwhile, Amy Congdon is working with tissue engineer Professor Lucy Di Silvio, at King's College London, designing digitally embroidered scaffolds on which to grow cells, in order to produce lab-grown jewellery. Many others have been courted by the foward-looking companies that have stepped in to sponsor the Textile Futures – now Materials Futures – course at CSM in the hope of getting an inside track on the most innovative, ecological or biological materials and processes that could help to differentiate their products. They include Nissan, Nokia and Microsoft.

But the most important role that design can play for the leading educators and practitioners in this multidisciplinary love-in is not to celebrate novelty and innovation for its own sake. It is to enter these bubbling cauldrons of collaborative science practice and partake of the excitement of discovery while applying a healthy dose of the pragmatism and user-

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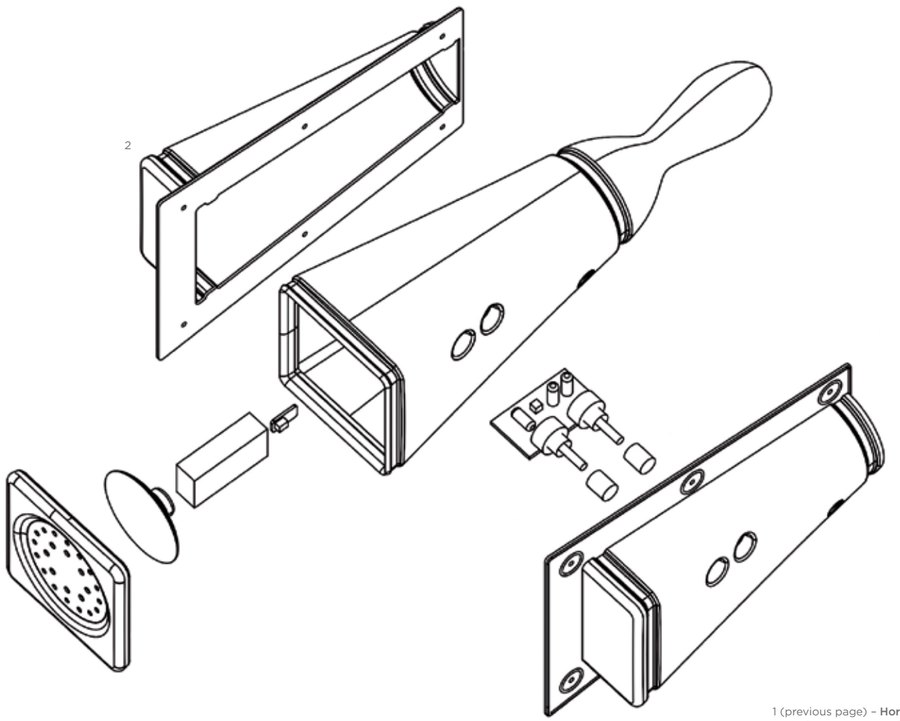
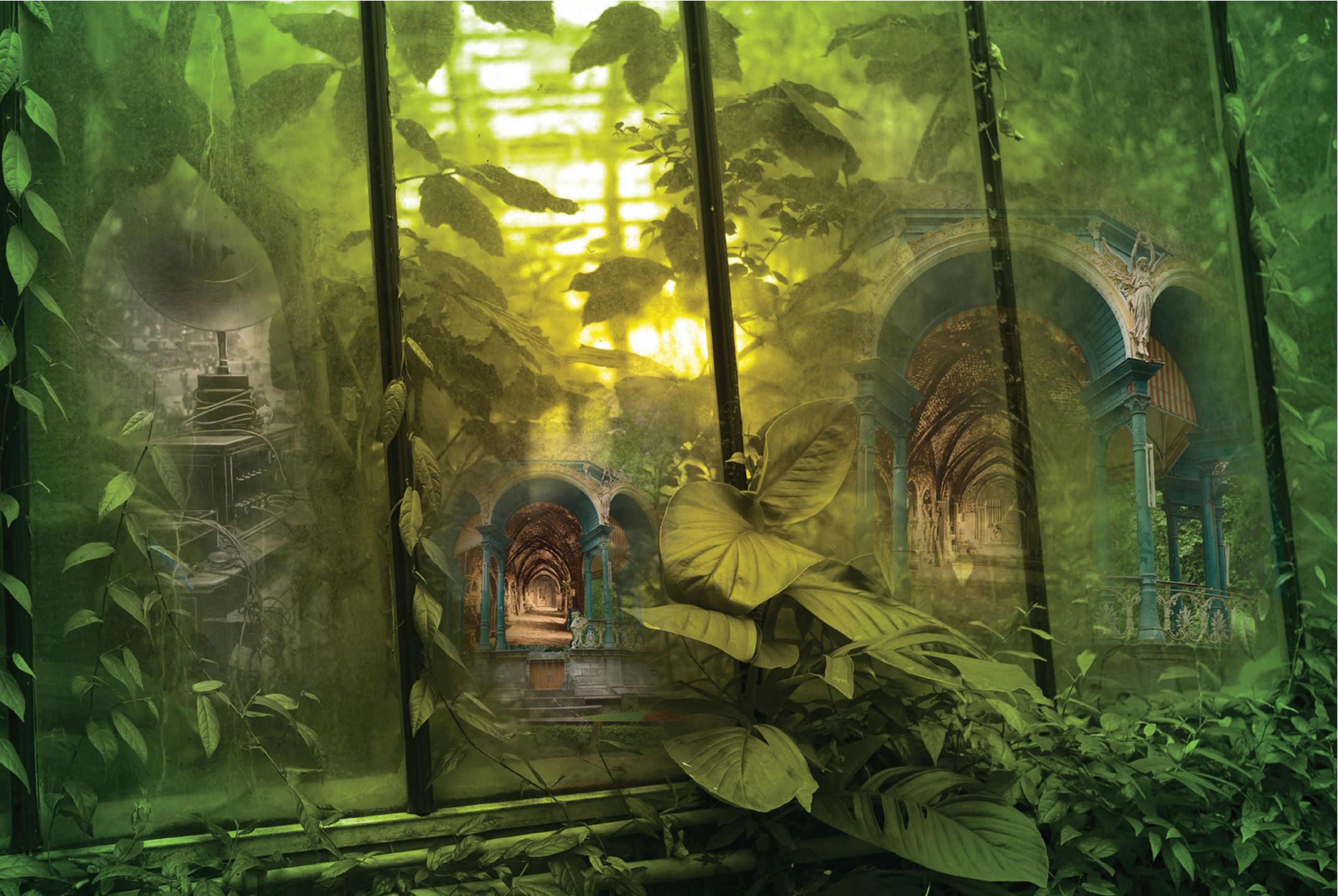


1 (previous page) – **Hortus Paris, by ecoLogicStudio**

2 – **Carole Collet's Botanical Fabrication**

3 (opposite page) – **Biolace Strawberry, a design project by Prof Carole Collet at Central St Martins, 2010-12**

1 PHOTOGRAPHY: LAURENT LECAT FONDATION EDF



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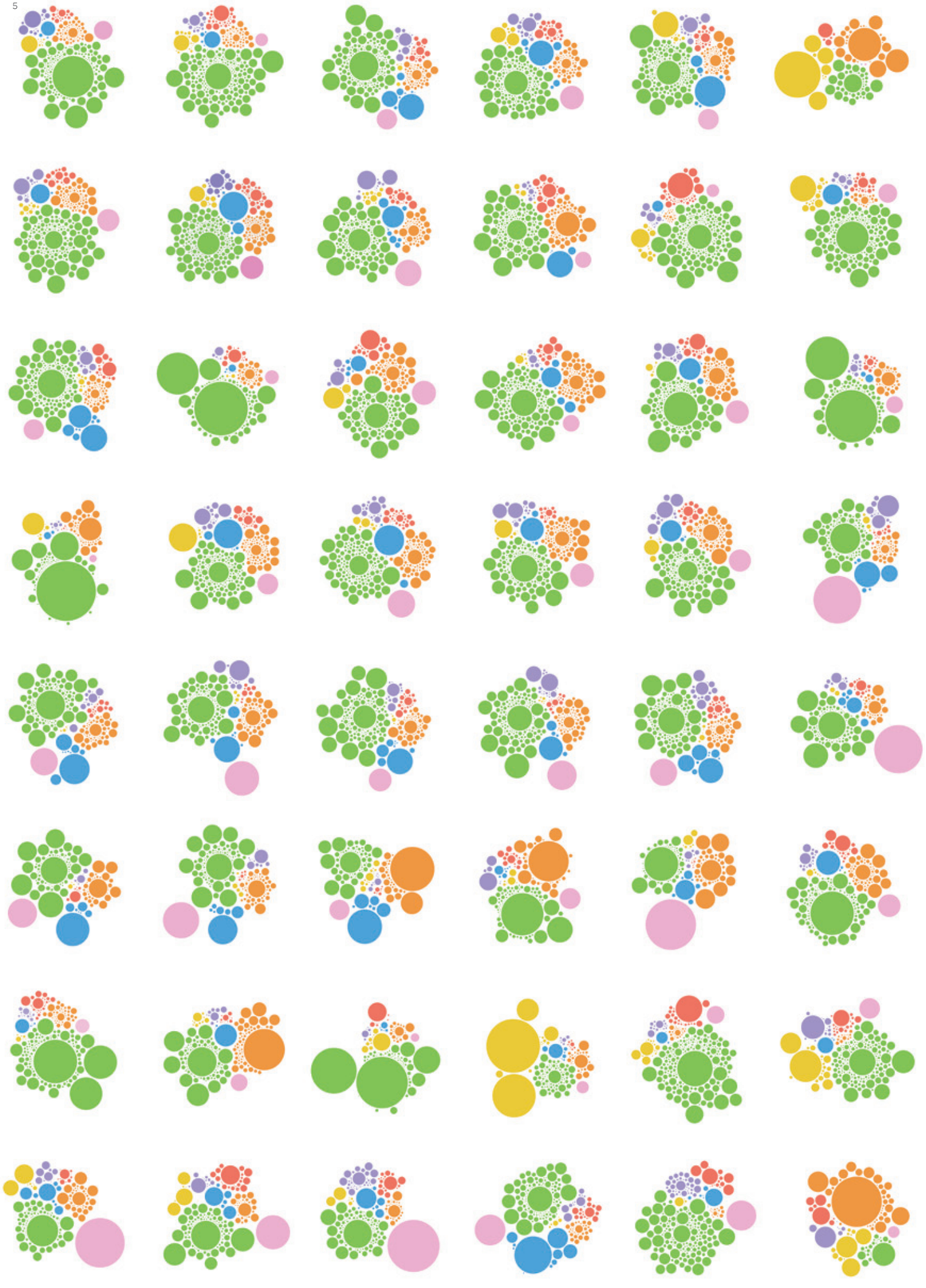

centric thinking for which design is famous – and science not. Where scientists experiment to test and 'prove' existing hypotheses (usually benefitting the corporations funding their research), designers experiment to explore new ideas, open to whatever conclusions may come their way, but always free to ask the key questions: 'What if?' and 'Why?'. Designers are uniquely well qualified to help scientists visualise and communicate applications for the materials and processes they are playing with. As synthetic biologist and designer Alexandra Daisy Ginsberg says in her book Synthetic Aesthetics: 'Pumping out limitless "green" jet fuel to feed planes or designing bacteria that secrete the same non-biodegradable plastics that already trouble us addresses neither the failures of our existing infrastructure nor entrenched attitudes to the ecosystem and our place in it.'

Synthetic biology is one of the most high profile of these hybrid design/science fields. It has dedicated university departments in all the world's leading science schools and its own global competition in MIT's iGEM (International Genetically Engineered Machine Foundation) contest. From five teams participating in 2004, iGEM has grown to host 245 teams in 2013, from 130 countries. And design and art are playing an increasingly important role: this year, there will be an iGEM prize for art and design (to be chaired by Ginsberg and her frequent collaborator Christina Agapakis).

SynBio (as it is frequently dubbed) is now so close to the mainstream of design that this spring it came out of the lab and into the galleries, when the Victoria & Albert Museum in London hosted an event curated by Ginsberg celebrating the launch of the aforementioned book. Among the live experiments on offer was human cheese created by artist/biologist Christina Agapakis and 'smell provocateur' Sissel Tolaas, using bacteria swabbed from people's hands, feet, noses and armpits. There was also a synthesised recreation of the sound of the first known hominid, Lucy, aka Australopithecus Afarensis, based on the dimensions of her vocal tracts and cords found with her skeletal remains.

The kind of multidisciplinary creativity curated by Ginsberg here is typical of a graduate of the Royal College of Art's design interactions MA, but where design interactions has become known for its students' dystopian visions of future technological landscapes, synthetic biology in the hands of designers errs more towards the utopian; as Ginsberg says: 'It is more looking at material possiblities.' And it's heady stuff. 'Biocouture' describes the possibility of growing bespoke clothes or shoes in labs, using templates around which bacterial cellulose can form. There is also biomimicry, as exemplified by the American-based resource Biomimicry 3.8, which has mentored and educated countless engineers, designers, architects and manufacturers towards the creation of carpets, furniture, manufacturing processes and even aeroplanes, all in nature's image. Architects and engineers have long been inspired by nature's

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6 PHOTOGRAPHY BY WWW.LORNAJANEWMAN.COM

4 (previous page) – **Borrowed Scenery, by FoAM**

5 – **In one of Christina Agapakis' latest projects, DNA was extracted from bacteria living in dirt for, among other things, an exploration of data visualisation**

6 –**The Biological Atelier is CSM materials future PhD student Amy Congdon's investigation into whether biotech can be used ethically by the fashion sector**

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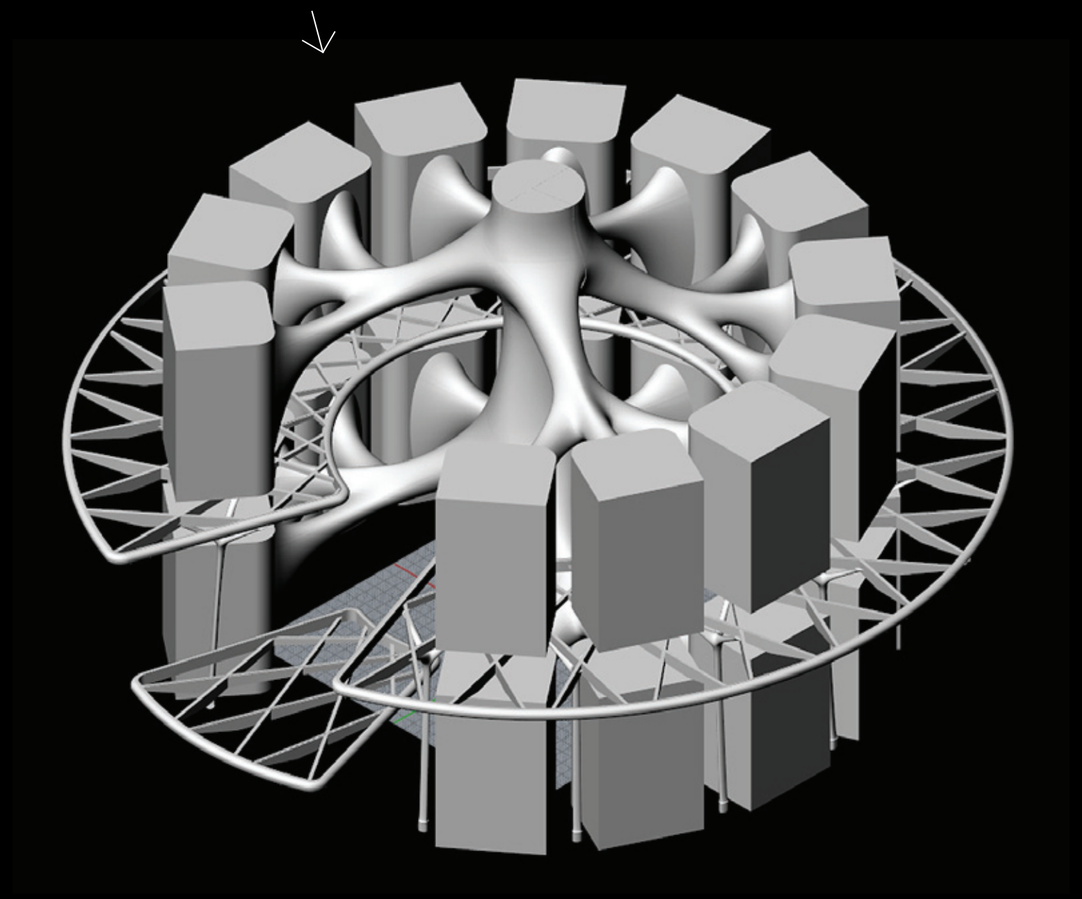

7 – The image of the leaf structure led Michael Pawlyn to a solution for a client's energy hungry IT equipment by locating its servers inside a mountain

8–10 – Synthetic biology has inspired the work of artist, researcher and writer Alexandra Daisy Ginsberg:
(8) SynKing Lung Tumour
(9) Seasons Void
(10) SynKing Gastric Trichobezoar

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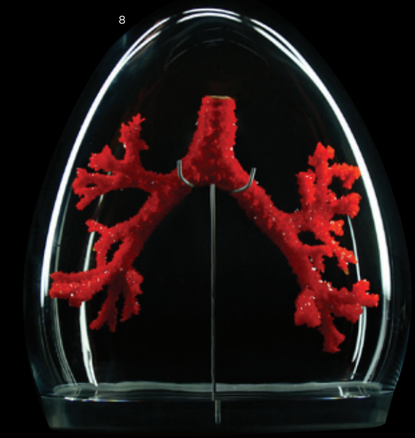

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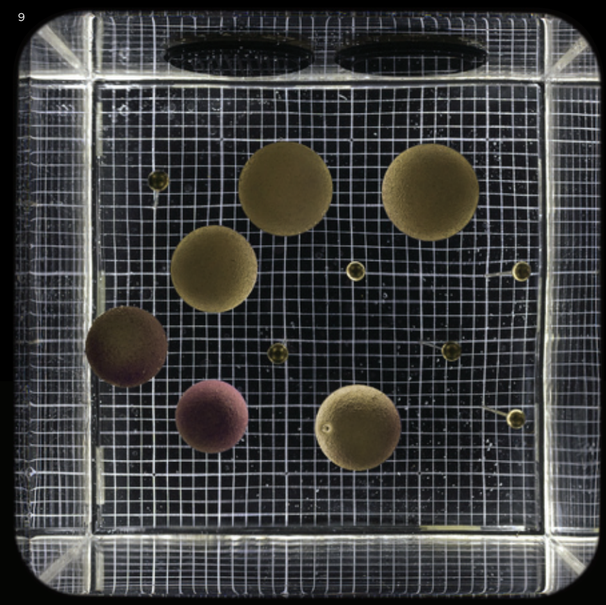

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elegance and economy in their designs – just think of Buckminster Fuller, Frei Otto, Santiago Calatrava, Sou Fujimoto, Thomas Heatherwick, to name but a few. But genuine, biology-led collaborations on materials and structure are still unusual, hampered by the rampant risk-aversion of the construction industry, so that architecture practices such as Jenny Sabin, Michael Pawlyn's Exploration Architecture and Tonkin Liu have rarely achieved the buildings they have painstakingly researched and conceived. Maybe the tide is turning here, with Pawlyn's extraordinary, dew-harvesting greenhouse, the Desert Forest Project (see profile, page 174) now up and running in Qatar and hopefully soon in Jordan. Pawlyn's biologically derived models and schemes were exhibited earlier this year at The Architecture Foundation. Architects Mike Tonkin and Anna Liu have also received a boost following a RIBA grant, for their exciting Shell Lace Structure and will mount an exhibition later this year.

So what of the future? While there is talk of synthetic biology or biomimicry offering solutions to many of the world's current problems, the mood among its key exponents varies. For Pawlyn, the issues in architecture are clear cut: 'One of the big drivers over the next couple of decades is towards radical increases in resource efficiency. In my talks, I often draw a contrast between the situation that existed at the start of the industrial revolution when resources were abundant and people were scarce, and now where we have the opposite. With that in mind, there's a very strong case for shifting away from simple, linear, disconnected systems that run on fossil fuels and produce lots of waste, and towards a more eco-friendly system, densely interconnected, that moves towards high efficiency and zero waste. That's what we're working towards: shifting towards a restorative paradigm.'

Perhaps worryingly, those at the forefront of materials science are less positive. Collet is in a delicate position, having had to court funding for her course from interested manufacturers while wanting to impose an ethical position on the output that her corporate backers may not share. 'I trust the scientists. They work with such ethical protocols. They do care about their reputation. I'm worrying about the manufacturing community trying to make profit, cutting corners; it's always a man-made disaster.'

With this in mind, Ginsberg makes the strongest case for beefing up the ranks – and the engagement – of a new generation of scientifically literate, critical designers: 'There's an inevitability to it all: increasing populations, diminishing resources. I can't tell a company it shouldn't be short-termist – suggesting it invests for 1,000 years rather than the quick buck. That's business thinking. That's where I think critical design can be something useful. If we are actually thinking how we redesign business, or redesign the way we think about business or think about science; it maybe a first world problem, but the ramifications are enormous and global.' ▶

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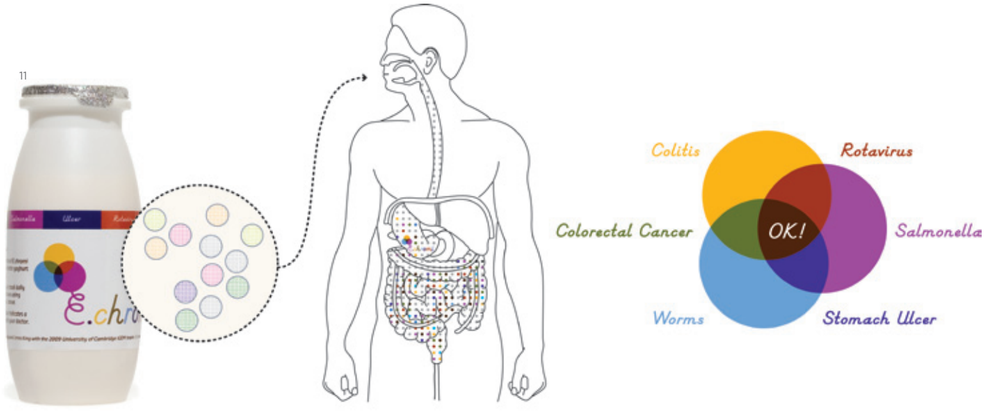

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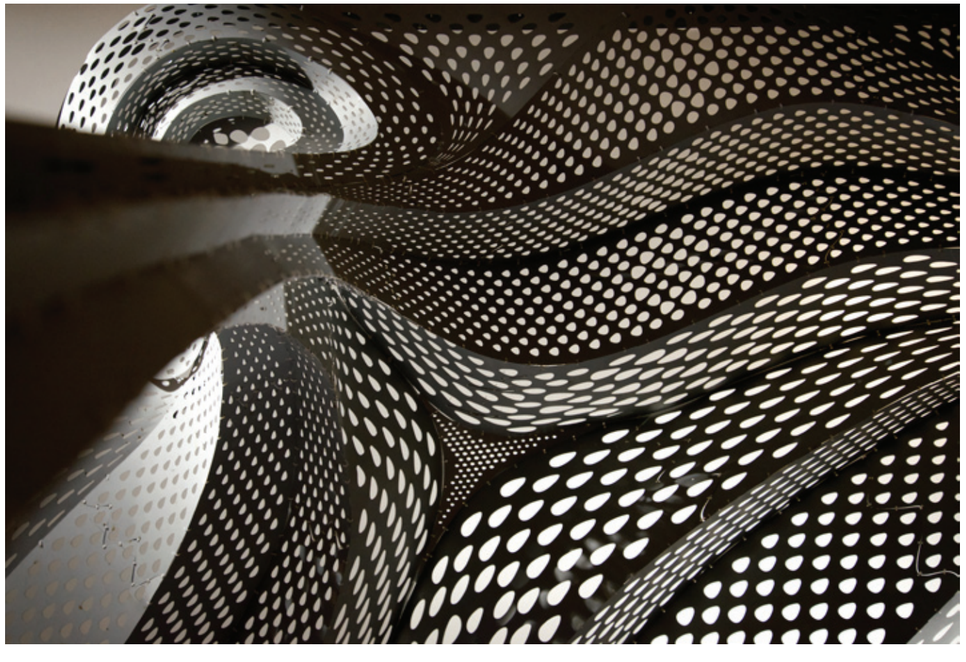

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11 – Alexandra Daisy Ginsberg's work on E. chromi, using DNA sequences to engineer bacteria that secrete visible colours and indicate toxin levels in water

12 & 13 – With a grant from the RIBA, Tonkin Liu has built 10 models of its Shell Lace Structures and exhibited them in its Portland Place building, London

14 (opposite page) – **Alexandra Daisy Ginsberg's 'Rewiliding with Synthetic Biology', featuring remedial membrane pumps.**

15 – **Dirt, a research project by Christina Agapakis**

16 – **Architecture practice Tonkin Liu is attracting attention with its Shell Lace Structure work**

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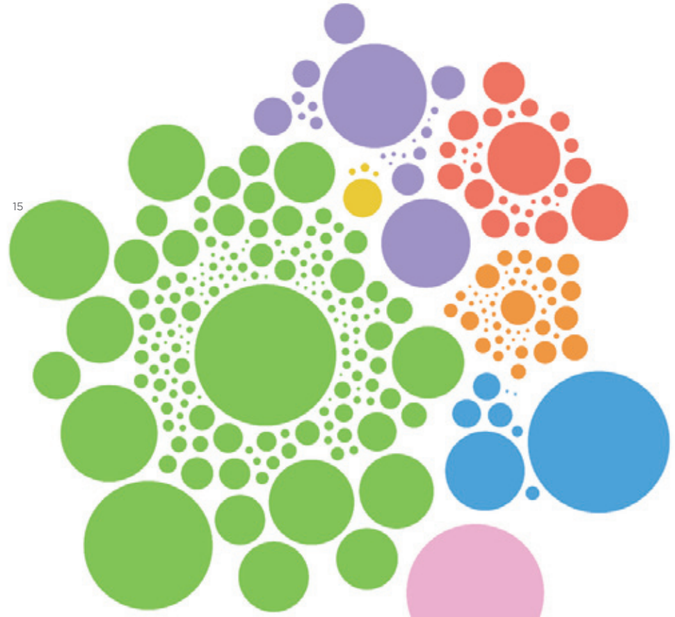

Practitioners:

ALEXANDRA DAISY GINSBERG

Synthetic biology is the inspiration behind the work of artist, researcher, collaborator and writer, Alexandra Daisy Ginsberg, but the driving force of her enquiries is to investigate the ethical as well as the aesthetic — the reasons for and repercussions of re-engineering nature.

She studied architecture at Cambridge and, after a brief stint in practice, worked in the Architecture and Urbanism Unit (now defunct) at London's City Hall where she was fascinated to learn a different way of thinking about cities, 'as more of an organic thing'. After a year at Harvard's MIT Media Lab, she signed up for the RCA's design interactions course. Here she came across synthetic biology and decided that 'this was what I was going to do — to see how far we could push design into an area that it hasn't been applied to before'.

One of her first collaborative projects, E. chromi, won the 2011 World Technology Award for Design, and she received the first London Design Medal for Emerging Talent in 2012. She is a sought-after facilitator for talks and collaborative workshops, whether brainstorming with chemical engineers at University College London, or 'looking at crabs and slugs as materials' at Imperial College London. As an artist and curator she has been creating visual evocations of possible (though not always desirable) futures such as 2013's Designing for the 6th Extinction, which is being revived for the forthcoming Istanbul Design Biennial. She was lead author on an acclaimed book on the field, Synthetic Aesthetics, published by The MIT Press this spring. She is now back at the RCA completing her PhD.

CHRISTINA AGAPAKIS

Cheese put Christina Agapakis' name on the map of experimental science-led makers, with her 'human cheese' project (first exhibited as Selfmade as part of the Grow Your Own exhibition at the Dublin Science Gallery in 2013), but her main fascination is: 'How can we design communities of microbes, how can we work at ecological as well as molecular scales, and how human cultures and bacterial cultures interact.' Current projects include one on dirt, funded by the University of California Institute for Research in the Arts: she is working with PhD student Ellie Harmon, who collected samples of dirt as she hiked the Pacific Crest Trail and sent them to Agapakis' lab, where they extracted DNA from bacteria living in the dirt and sequenced the 165 ribosomal RNA to identify what species of bacteria there were (http://dirtmap.org).

The experiment is an exploration of data visualisation, condensing biological information into DNA sequences and the technologies that help us interact with nature. She is also setting up her own design practice, Icosahedron Labs, and thinking of starting an online course in synthetic biology with the Center for Research and Interdisciplinarity in Paris. Agapakis has also been working on Method Quarterly, a new online magazine about the 'edges' of science, where it meets art and culture. She is an adjunct professor at Art Center College of Design, Pasadena, where she has been teaching designing for and with the microbiome. And this year, along with Ginsberg, she will be chairing the new iGEM Art and Design track, where, for the first time, teams can be awarded prizes for their artistic contribution to synthetic biology.

TONKIN LIU

Anna Liu and Mike Tonkin are landscape architects as well as architects, so it's no surprise that a love and respect for nature runs through their practice. For the past five years they have been working with Ed Clark at Arup and a mollusc specialist to evolve a structure combining the strength, lightness and resilience of seashells with fine tailoring and digital design tools. The result, Shell Lace Structure, 'is all about lightness and using the minimum amount of materials through using forms in nature that are very strong,' says Liu.

Tonkin Liu has been shortlisted in many competitions for its elegant and streamlined forms, but fallen at the ultimate hurdle thanks to an attitude of 'Oh, now this can't be built in a conventional way,' says Liu. 'There have been times when innovation only succeeded because of a real partner being on board.' Its fortunes may be turning though: with a RIBA research grant in 2013, 10 models of proposed Shell Lace Structures were exhibited; it has run an MA course on the structural possibilities of Shell Lace; it has won an RIBA design competition for a Shell Lace Structure bridge in Salford, and published a book on Shell Lace. ▶

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17 – **Future Fabulators from FoAM, founded as a government initiative**

FOAM

Started in Brussels in 2000 as a government-funded initiative, FoAM'S business is 'reimagining possible futures at the interstices of art, science, nature and everyday life'. A 'think and do' tank, it has European Commission funding, and a 'network of transdisciplinary labs for speculative culture', with outposts in Amsterdam, Stockholm and Cornwall. One of its first initiatives involved developing 'seedling worlds in mixed reality — a place where digital media become more tangible and physical materials more responsive'. Its longest-running initiative, groWorld, started with a series of responsive, generative mediascapes that allow people to shape invented worlds and play out the consequences of their behaviour on the natural and social environment

It led to a project connecting living gardens with online games, and most recently an 'entangled alternate reality narrative' called Borrowed Scenery, where people communicate with plants in an imagined landscape of vivid, animal-vegetal interactions. Recent initiatives include Resilients, a series of workshops prototyping possible responses to cultural, environmental and economic turbulence. FoAM's multidisciplinary team draws extra revenue from workshops and consultancies, runs residencies and develops interactive games to facilitate explorations of animal, natural and digital worlds. It hosts ongoing online experimental forums such as Future Fabulators, which proposes a series of speculative scenarios, based on topics emerging from their workshops.

MICHAEL PAWLYN

Michael Pawlyn is a pioneer of biology-inspired architecture. Through his firm Exploration Architecture, his approach is to 'work with scientists to develop concepts and then find clients to make these concepts a reality'. Together with his biologist colleagues, he seeks solutions to problems of sustainability, though he prefers the term 'restoration'.

He has worked with fairly mainstream clients to conjure up groundbreaking ideas inspired by nature, only a few of which have yet been realised, though the list is growing. In 2012, he built his Sahara Forest Project for the Qatari government — greenhouses inspired by the desert-dwelling Namibian beetle's ability to harvest dew, thanks to the unique structure of its forewings, covered in microscopic bumps with water attracting tips and repelling sides. (It directs these wings at the oncoming fog of desert dew each morning and then slides the water droplets that materialise down channels into its mouth.)

The Jordanian government is now looking to replicate it. Pawlyn's elegant forms and ideas were exhibited this year at The Architecture Foundation, including the Biometric Office, which maximises light through connecting a series of smaller narrow-floorplate office blocks around a central atrium, in the middle of which is a giant light reflector that bounces light into them. He has also addressed the problem of energy-guzzling IT equipment for one client by locating its servers inside a mountain in Switzerland. It's very James Bond-ish,' he says.

CAROLE COLLET

Carole Collet is a leading thinker, researcher, designer and curator whose work explores 'ways in which biological principles and living technology can interact with design to create a more resilient future'. The textile futures course she founded and directed until recently (which has now evolved into Materials Futures) at Central Saint Martins has been enormously influential, both in and beyond the college. Collet is now about to establish a full-time interdisciplinary research laboratory at CSM, the Designing & Living Systems Lab, whose focus will be 'design-led investigations of biological sciences to explore new design methodologies and to develop innovative sustainable products and services'. Her recent research projects include Biolace, a speculative design project looking at how synthetic biology could impact on future fabrication. She curated Alive, Designing with Living Technology, a groundbreaking exhibition of experimental biology-inspired design at the EDF Foundation in Paris, which ran from April to August 2013. She also developed an exhibition with the EDF demonstrating how gourds can be grown in moulds to replace plastic components in small electrical goods (Botanical Fabrication). Her ambition is to turn the table on the status quo (science occasionally availing itself of designers' visualisation and communication skills): 'My ambition is to have design-led science. We find pertinent research questions to give to the scientists.' In her new lab, she promises to spread the net wide: biomimicry, botany, synthetic biology will be applied to everything from architecture to product design. ■