MATERIALS AND DESIGN EXCHANGE

De-CONSTRUCT:Re-CONSTRUCT

Innovation in bicycle materials and design

The Materials and Design Exchange (MADE) Summer School 2007

INNOVATIVE DESIGN, ADVANCED MATERIALS AND RADICAL MANUFACTURING FOR SAFER, MORE CONVENIENT CYCLING.

What happens when 40 of the most talented design, engineering and materials science students in the UK come together with luminaries from the world of bicycle design to create a vision for a future generation of comfortable, practical cycling products? A lightweight wearable cycle lock that doubles as a reflective sash, an electronic tag that alerts HGV drivers to the presence of cyclists in their nearside blind spot and a handlebar bag with lighting integrated into its fabric were just some of the ideas from teams given just two days to come up with designs to make bikes better.

De-CONSTRUCT: Re-CONSTRUCT
Innovation in bicycle materials and design was organised by InnovationRCA at the Royal College of Art for MADEconnections, the student arm of the Materials and Design Exchange (MADE).

MADE is part of the Materials Knowledge Transfer Network (KTN) funded by the UK Government's Technology Strategy Board (TSB). It aims to forge links between designers and other sectors of the KTN concerned with metals, plastics, textiles and the full range of modern materials, in order to bring the materials science and design communities together in the pursuit of better products and the creation of wealth for the UK.

The core partners of MADE are the Institute of Materials, Minerals and Mining (IOM3), the Royal College of Art (RCA), the Design Council, the Institution of Engineering Designers (IED) and the Engineering Employers Federation (EEF South).

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The two-day De-CONSTRUCT: Re-CONSTRUCT MADE Summer School, held at the Royal College of Art in London and jointly hosted by Imperial College was a rare opportunity for students of different disciplines to work together. Forty students from around the country worked in six teams with mentors from the cycling and design industries to produce new ideas at the event.

"The MADE project is all about combining the expertise of the UK's materials community with the creativity of our designers," says John Bound, MADE working group member and Head of Innovation Development, InnovationRCA at the Royal College of Art, the organiser of the event. "But this is the first time we've brought students from the different disciplines together and asked them to cooperate in order to produce innovative ideas in an extremely short time."


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Expert advice


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Along with their imaginations and some of the world's best bicycle design expertise, the students in the Summer School were given an insight into the materials and manufacturing processes that will enable the bicycle designs of the future. MADE design mentor Geoff Hollington ②discussed the emerging world of rapid, or additive, manufacturing technology – the use of advanced methods to build parts automatically from liquid and powder materials – while Dr Sumeet Bellara, MADE design technologist at the Institute of Materials, Minerals and Mining and Dr John Hodgkinson of the Composites Centre at Imperial College①were on hand to explain and demonstrate a broad range of innovative new materials from light, strong carbon fibre composites to the latest shock-absorbing polymer gels.

The event began with a series of talks on the history and development of the bicycle from Mark Sanders③, RCA alumnus, designer of the popular Strida folding bike and Mike Burrows ④, renowned bicycle innovator, ex designer at Giant, the world's largest bicycle company and designer of Chris Boardman's Olympic winning Lotus bicycle. The participants then completed an in-depth brainstorming session.⑤,⑥"A 40 person brainstorm is normally quite a difficult thing to do, but in fact it was a fantastic success," says Ashley Hall, Senior Tutor, Industrial Design Engineering at the Royal College of Art and a team mentor at the event.

Practical problems

Perhaps surprisingly for a group formed largely of cycling enthusiasts, none of the teams chose to develop elaborate racing machines or exotic lightweight hardware. Instead, all elected to work on designs that would help cycling become easier, more convenient and safer as an everyday means of transport. "While we had a really broad range of ideas, the participants were almost universally focused on issues of accessibility and inclusiveness, of opening up cycling to the widest possible group of users," says Ashley Hall.

To complete their initial examination of the problem, the whole group headed across the road to Hyde Park to test ride a wide variety of different bicycle designs ⑦,⑧. For Gareth Jones, designer and visiting tutor at the Royal College of Art, another team mentor, the test ride was a powerful part of the learning process. "It is intriguing to see that in bike design there are so many different successful solutions to basically the same problem," he says. "That in itself is an important learning point for anyone involved in design. Seeing and using the product first hand gives you a much deeper insight into the nature of the problem."

> The MADE Summer School gave me a real insight into the methods by which designers, engineers and scientists can work together. I know that the ability to collaborate across multi-disciplinary fields will be invaluable in my future scientific career. Ruth Sayers, PhD, Materials, Imperial College


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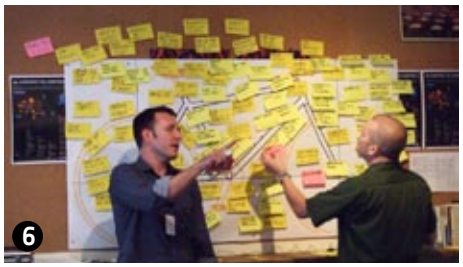
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Rapid teamwork

Armed and inspired, the teams spent the next 24 hours developing their ideas as sketches and prototypes⑨–⑬. For many participants, particularly those from science and engineering backgrounds, this was the first time they had been asked to apply their knowledge in the context of a real design process. "Engineering and science students are given fantastic analytical tools, but they rarely have the opportunity to apply them in this kind of environment," says Gareth Jones, "It was a real eye opener for them to be exposed to the design process and to understand the process of stepping back and looking very broadly at a problem before focusing on a solution." Ashley Hall agrees: "Engineers and scientists often want quick, black and white answers, whereas designers are much happier working with grey information until quite a late stage. During the process the engineers learned to be much more open minded about different options."

The science community was able to make a strong contribution too, as Ashley Hall explains. "My group wanted a material that could absorb carbon dioxide from the atmosphere as the bike was being ridden. We thought that we were talking about science fiction, but Sumeet Bellara of MADE quickly identified some materials in development at the moment that might give us the properties we wanted."

"Putting such a great mix of people together is fantastic," says Gareth Jones. "In environments like this students learn as much from their peers as they do from their tutors."

Speed was of the essence too. With little time to agree on their concepts and realise them, the groups were under considerable pressure, which meant they had to learn fast how to work well together. "Some people had little experience of team work and it is such an important skill. You may be able to work alone for most of the time as a student, but in the real world almost everything involves cooperation and compromise," notes Gareth Jones. "The tight time constraints also meant that students had to make effective use of simple design tools like sketching and model making. Even in the world of computer aided design, the ability to think in three dimensions and to articulate your thoughts quickly using those techniques is an essential skill."


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> The brainstorming session focused the participants' attention on broad social and environmental considerations, exploring the benefits of cycling as a more inclusive and safe method of transport. These considerations became strong influences in the design process. Professor Clare Johnston, Head of Textiles, RCA

Judgement day

In the afternoon of the second day of the Summer School, all the groups presented their designs to a distinguished judging panel including Richard Ballantine, author of Richard's Bicycle Book; Sir Alex Moulton, RDI, designer of the small wheel, suspension bicycle, Stuart Dennison, owner of London cycle retailer Bikefix, Martin Strangwood of Birmingham University Sports Materials Research Group and Graham Barnes of engineering consultancy Engenuity⑮.


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Radical solutions

'Wearable Lock', the winning design selected by the judges, was an advanced cycle lock that could be worn as a high visibility reflective sash⑯. Intended to replace conventional heavy chains, the new approach used a woven composite


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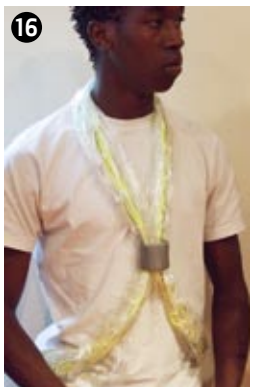

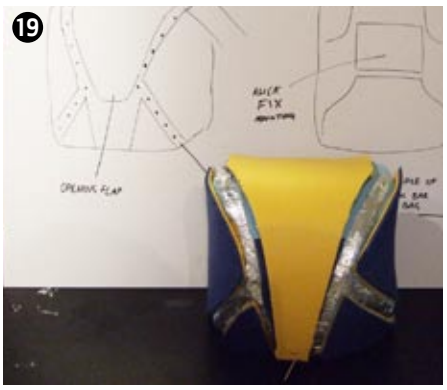

different materials. Steel cable, Kevlar strands and soft, sticky plastic fibres were included in the mixture in order to blunt, gum up or deflect all the common tools of the cycle thief. To eliminate any possible weaknesses, the lock was woven in a long, continuous loop (17), (14) connected by a lock mechanism built using the latest laser sintering technology (a rapid manufacturing technology) to eliminate any unnecessary openings or structural weaknesses. In keeping with the spirit of the event, the winning team even fashioned a simple loom from a bicycle rim (13) in order to manufacturer a prototype of their design.

The runner-up designs also attempted to tackle some of the key barriers to a greater uptake of cycling as urban transport. 'Bike Eyes' (18) (second) uses advanced technology to tackle the issue of cyclists being struck by left-turning heavy goods vehicles, one of the principal causes of bicycle fatalities in London. The system uses the Radio Frequency Identification (RFID) technology now used by supermarkets to protect high value goods from theft. A passive RFID tag sticker weighing a few grammes is fixed to the frame of a bicycle. A sensor mounted in the cabs of trucks and buses can then detect the nearby tags and give the driver a visual and audible warning of the proximity of a potentially vulnerable cyclist. The team estimate that tags could be sold to cyclists at a cost of £1, with profits funding the distribution of sensors to bus and HGV operators.

This was the first opportunity I've had to apply some my materials knowledge to my passion – cycling – and a fantastic insight into the industry. Rowan Leary, BSC, Sports Materials Technology, University of Leeds

Carried forward

In third place was 'Light Bag', a solution to the difficulty in carrying personal possessions while cycling. The team's solution was a smooth, moulded handlebar-mounting bag with a quick release fitting (19). A system of light emitting diodes and optical fibres incorporated into the skin of the bag allowed it to light up at night, becoming a distinctive and highly visible indicator of the cyclist's presence.

Other ideas developed by teams in the Summer School included a luggage rack that converts into a lock (21), a saddle with integrated storage space (20) and a scheme that allowed bicycle owners to exchange the mechanical elements of their machines at regular intervals for service or renewal (22).

The winning design was realised in spectacular fashion after the event. Technicians at RapidformRCA, the RCA's Rapid Manufacturing Centre, built a physical model of the lock mechanism overnight using their Eden digital printing technology. The part was rushed across London by courier the next day to be received at the Institute of Materials by Dr Robert Quarshie, Director of the Materials Knowledge Transfer Network (23) and displayed at the IOM3 conference on Materials in Bicycles. "Combining the skills of designers, engineers, and materials scientists has huge innovation potential," concludes John Bound "This event was proof of that."