also disseminate management and communication skills that will help students develop their careers. Together, the various AIMS have already awarded more than 1,500 masters' degrees to students from more than 40 countries.

The different arms of the New Einstein Initiative are not alone in trying to cultivate science in Africa. Carnegie Mellon University, in Pittsburgh, Pennsylvania, established a campus in Rwanda in 2011. Carnegie Mellon University Africa, as this campus is known, awards masters' degrees in information technology and in electrical and computer engineering. As Crystal Rugege, its director of strategy and operations, observes, information technology "cuts across all sectors when you're trying to develop an economy".

Ms Rugege also points out a systematic problem of African academia, which is that universities on the continent rarely encourage their professors to do research. The emphasis is on teaching, which is the criterion for career progression. Reforming the academic-promotion system would thus help spur research.

Will ye no come back again?

Equally crucial is the process of giving talented students a route to the top. To do this properly would require school reform that is beyond the remit of the New Einstein Initiative but, by creating African institutions of international standing in the form of the AIMS, it can enable those who have got to university to do graduate work without the expense and disruption of travelling to North America or Europe.

Keeping African talent in Africa in this way during people's life-defining early 20s may also reduce the proportion of those who go on to make their careers abroad. In this context Dr Masa's path is perhaps instructive. He grew up in the mountains of rural Uganda, on a family farm that lacked electricity and running water. He excelled at school, obtained a place at Makerere University in Kampala, entered Uganda's national mathematics competition, and came second. To pursue research, though, he had to take a scholarship at Bochum—and, apart from a stint at Oxford, he has remained there ever since.

In his case, he might eventually go back home. He muses about returning to Uganda to teach at a university, even if it means not pursuing ground-breaking research. In Uganda, he thinks, he can make a bigger splash than in Germany. "Sometimes," he says, "you do things for the larger good." Not everyone will be so altruistic, though. Even putting aside the higher salaries found abroad, spouses and social networks there are powerful anchors. If the New Einstein Initiative can encourage those anchors to be forged and dropped nearer home, it will have done Africa a considerable favour. ■

Automotive engineering

The art of reflection

How paint jobs can make autonomous cars safer

CUSTOMERS could, Henry Ford once quipped, have a car in any colour they wanted so long as it was black. In the end consumer choice got the better of him; cars now come in all manner of complexions. Black, nevertheless, remains popular. Some 17% of new cars sold around the world are black, second only to white, at 37%. White is favoured in hot countries because, along with silver, it is good at reflecting light—including the infra-red wavelengths that carry most of the sun's heat. Black, grey and other dark colours, in contrast, absorb light, thereby warming cars painted in those hues.

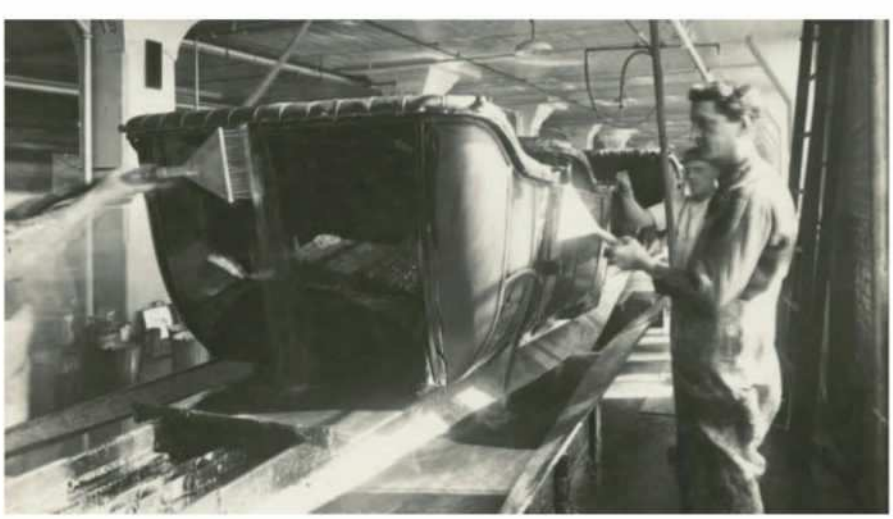
Despite Ford's equivocations, none of this has, until recently, presented carmakers with much of a problem. That is changing because, besides absorbing sunlight, dark shades also tend to absorb much of the signal transmitted from the increasing number of sensors being fitted to vehicles.

Radar sensors are used to operate safety systems such as automatic braking. They transmit radio waves and measure the time it takes for those waves to bounce back, and any changes in their frequency. From this it is possible to determine the range, position and velocity of objects around a vehicle. If some or all of the signal is absorbed instead of being reflected, though, radar sensors can miss things.

The same is true of lidar, which is similar to radar except that it employs infra-red laser light instead of radio waves. At present lidar is big and bulky (the blob-shaped roof racks on self-driving cars are lidar sets) but miniature versions are being developed. Though self-driving cars have suffered setbacks recently (in March a pedestrian was killed in Arizona by an Uber test vehicle fitted with lidar and a Tesla running on radar-assisted Autopilot crashed and killed its driver in California), both radar and lidar are likely to be used more widely as cars become more automated.

To improve the reliability of sensors it would help if all vehicles were painted in colours that are good at reflecting a wide range of wavelengths. But that is not going to happen, for the same reason Ford had eventually to introduce shades other than black—namely that colour is an essential part of vehicle design and marketing. But PPG, a firm in Pittsburgh that is one of the world's biggest suppliers of paints and coatings, believes it has an answer. Its researchers are tampering with paint at a molecular level so that whatever colour a coat of it appears to be to the human eye, it will still be highly reflective to the signals from a car's sensors.

Painting cars has become a high-tech process. Painted surfaces are now so good that cars barely rust as they once did. Arriving at this perfection involves the extensive cleaning and preparation of the surfaces in question, and the spraying of several layers of different formulations of paint in precise ways, usually by robots. As the layers dry, chemical reactions can change the size and spacing of pigments within them to produce such effects as vibrant colours or deep, rich tints. It is this sophistication that has allowed PPG's paint technologists to make dark colours reflective to the sig-



Reflecting on times past

nals from sensors.

The clue as to how to do this came in the form of an aubergine (or eggplant, as it is known in America). The aerospace division of PPG had already solved a different problem—that of keeping aircraft painted in dark colours cool—by basing the way they paint these aircraft on the dark-purple skin of aubergines. Instead of absorbing infra-red radiation, an aubergine's skin permits such wavelengths to pass through. They are then reflected back out again by the vegetable's white interior flesh. That way, an aubergine in a sunny field remains cool. By dispersing specially engineered pigments in a dark-coloured surface layer over the top of a reflective white underlayer, PPG was able to achieve the same thing for aircraft paint.

And, as David Bem, PPG's chief technology officer, observes, what works for solar heat also works for the sensor radiation bounced back from cars. This permits a similar approach to be taken to the painting of vehicles in dark colours. Dr Bem also reckons that a reverse approach could be used to tone down, in relevant frequencies, road signs that are designed to be super bright to people but thus risk blinding lidars. In such cases, Dr Bem says, it is possible to engineer the pigments and layers of paint in ways that retain the brightness for human eyes but tone down the dazzling effect on artificial ones. ■

Psychology

Heart and soul

Links between musical preferences and personality are put on a firm footing

PAST attempts to link personality to musical taste have foundered on the rocks of small sample sizes, culturally homogenous samples (usually of undergraduates at universities in rich countries) and the fact that most such studies relied on the participants themselves defining what genres they enjoyed. But Jason Rentfrow of Cambridge University and Gideon Nave of the University of Pennsylvania think they have bypassed these obstacles. As a consequence they believe, as they write in *Psychological Science*, that they have shown how personality traits can indeed predict musical preferences.

To overcome problems of sample size and diversity Dr Rentfrow, Dr Nave and their colleagues used the internet to recruit 22,252 participants of different ages and backgrounds from all around the world. In particular, 45% of their volunteers were over 22 and thus unlikely to be undergraduates. To work around the problem of letting participants define what they liked, they presented each of these volunteers with 25 excerpts of music that had not been publicly released but had been assessed and classified by expert musicologists. Each volunteer was also given a standard personality test that rates the five main components of personality: openness, conscientiousness, extroversion, agreeableness and neuroticism.

Openness, Dr Rentfrow and Dr Nave found, was associated with an appreciation of "sophisticated" music (defined as inspiring, complex and dynamic) and a converse lack of appreciation for "mellow" music (romantic, relaxing and slow) and "contemporary" music (percussive, electric and not sad). Extroverts, by contrast, showed a preference for "unpretentious" music (uncomplicated, relaxing and acoustic). Those who scored high on agreeableness showed the appropriateness of that assessment by rating all the clips highly, regardless of genre. And those with elevated neuroticism scores did the reverse, rating everything as bad. Only the trait of conscientiousness failed to predict musical taste in any way. Perhaps conscientious people have better things to do than sit around all day listening to music. ■

Palaeontology

Eyes of the beholder

An ancient lizard had an extra pair of peepers

UNLIKE invertebrates, most of which have at least four eyes, vertebrates usually have only two. Yet, there are exceptions. Some fish, amphibians and reptiles have a third, so-called parietal, eye. This organ, a modification of a brain structure called the parapineal gland (itself an associate of the better-known pineal gland, which regulates an animal's body clock), is usually covered with skin and sits on the top of the head, as the picture below shows. It helps those creatures that possess it to detect low-level illumination, and so aids navigation by moonlight or starlight.

For vertebrates to have four eyes, however, is unusual in the extreme. The only ones known that are so endowed are the lampreys. These have two conventional eyes and two parietals, one derived from the parapineal and the other from the pineal. But lampreys' exceptionalism in this respect has just been challenged. This week Krister Smith, a palaeontologist at the Senckenberg Research Institute, in Germany, reports in *Current Biology* that, 49m years ago, the four-eye club had another member—a lizard called *Saniwa ensidens*.

The specimens which led Dr Smith to this conclusion have languished in Yale University's palaeontology collection since their discovery in Wyoming in 1871. Initial examination of them revealed an odd extra pair of holes in the skulls behind the eye sockets. But, since these holes were roughly a tenth the size of the eye sockets, the examiners concluded that they were passages for blood vessels and the strangeness of the lizards was soon forgotten.

Dr Smith stumbled on the specimens while conducting a study on lizard diversity. He found it hard to accept that the extra holes were for blood flow, reasoning that if they were, indeed, there to permit the passage of blood vessels, then re-entry holes of a similar size would exist elsewhere on the skulls for the blood to return to the rest of the body. But none such could be found.

What he did find, by comparing the locations of the holes with the skulls and brains of 179 living lizard species, was that they would have been above *Saniwa*'s pineal and parapineal glands. Moreover, when he used computerised tomography, a sophisticated form of x-ray scanning, to study the insides of the fossil skulls, he discovered within each hole a cup-shaped structure with a stalk behind it. This anatomical arrangement is characteristic of eyes of all types. The cup is the retina. The stalk carries the retina's nerve connections and blood supply. Given all this Dr Smith and his colleagues argue that *Saniwa*'s extra skull holes were the sites of pineal- and parapineal-derived eyes of the sort possessed by lampreys. If so, they have discovered a first—a four-eyed terrestrial vertebrate.

Spot the eye in the back of the head