Writing an initial draft:

- Choose any topic you like
- Make an argument and back it up with evidence
- Aim for 800 words and 6-8 paragraphs
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Our aim over the next two days is to achieve a systematic improvement with an iterative, evolutionary approach to editing.

Write About Science WAS

What to write?

- Choose a topic you care about!
- Write an essay making an argument for the importance of some policy, research programme, etc. Back your argument with evidence
- Write a research statement, describing the aim of your research and why it is important.
- Write the introduction (or more) of a research paper.

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THIS WEEK

EDITORIALS

MOVIE-MAKING Screen techniques show how ancient amniote walked **p.266**

WORLD VIEW Payments for papers push professors to predatory journals **p.267**

MATHEMATICS Topology pioneer Michael Atiyah dies, aged 89 **p.271**

Super structures mimic metals

Concepts in metallurgy combine with 3D printing in an approach to designing strong, lightweight materials.

Astronauts on the International Space Station have had access to an orbiting 3D printer for several years now. But the real advances are being made down on the ground. The technology might be known among the public for turning out trinkets and expensive gifts, but steady progress is also being made in more challenging engineering applications.

Take the fabrication of complex network structures known as architected materials. These 3D structures can be carefully designed to achieve high strength-to-weight ratios compared with those of many conventional solid structures. They require less material than a fully solid structure to achieve similar performance capabilities, making them potentially resource-efficient. And the weight saving means that less energy is required to carry them about, making them intriguing for applications in which energy efficiency is a priority, such as prosthetics or aerospace technology. Such structures are, however, very difficult to fabricate using conventional techniques. And that is where 3D printing — also known as additive manufacturing — comes into play.

In this week's *Nature*, scientists at Imperial College London and the University of Sheffield, UK, report how they used 3D printers to create an unusual — and potentially very useful — series of architected materials by borrowing concepts from metallurgy (M.-S. Pham *et al. Nature* **565**, 305–311 (2019); see also page 303). They deliberately introduce what look like imperfections into 3D-printed plastic and metal lattices, to make them stronger. This strategy mimics on a larger scale the structural and compositional imperfections that can enhance the mechanical performance of normal crystalline materials: the lattice of the architected material stands in for the atomic arrangement in a crystal.

In one class of architected structure, the researchers created a material mimicking a polycrystalline structure — that is, one in which, instead of a single regular lattice structure, the material is broken up into 'metagrains' with different lattice orientations. Furthermore, they were able to tune the size of these regions to replicate a known effect in which mechanical strength is controlled by grain size. (In a standard polycrystalline metallic system, it is the boundaries between the grains that hinder material deformation.)

In another approach, the scientists mimicked a technique called precipitation hardening, often used in the manufacture of high-performance alloys. They also studied dual-phase lattices (mimicking steels). They speculate that 3D printing could be used to give structures the same kind of reversible stress-induced phase transformation as is seen in superelastic materials — a desirable property in cases where resilience to, and recovery from, deformation is required.

The authors explored three very different materials for their structures, requiring three different printing technologies. As expected, the properties of these materials were important. Further base materials could be investigated, and other mechanistic approaches for controlling properties are available. The parameter space for future exploration is large.

These demonstrations are just proof of principle; architected materials more generally are still a very new concept. Much work needs to be done before these ideas can be used widely. For example, researchers need to be able to make much larger structures, to exploit the breadth of available engineering materials and to develop design tools that can cater for the complexity of real-world applications.

But 3D printing more generally is now making genuine inroads in manufacturing. Industrial researchers have found additive manufacturing in metals to be appealing because it creates much less waste than does machining sections from a solid block; as such, it is now being used to mass-manufacture a few specific aerospace components. And US aerospace company GE Aviation says it has used additive manufacturing to improve weight efficiency in its new Affinity supersonic jet engine — scheduled to fly in 2023 — making supersonic travel that bit cheaper. As we wrote in a Toolbox article this month, it is also making inroads in the research laboratory (see *Nature* **565**, 123–124; 2019).

"It is said that 3D printing will be a key feature of the fourth industrial revolution."

It is sometimes said that 3D printing will be a key feature of the fourth industrial revolution, the era of big data, connectivity and human–machine integration. Metallurgy — specifically, developments in iron and steel manufacture — was central to the original Industrial Revolution. Metal endures. And now, architected materials enabled by metallurgical know-how and 3D printing could also go from strength to strength. ■

Screen time

How much is too much? An analysis tries to get to the bottom of a crucial question.

It has become a defining question of our age: do children and adolescents spend more time than is healthy staring at a phone, tablet or computer? Should parents limit their access? Should governments?

Nearly all US teenagers say they have access to a smartphone, and about half say they are online almost constantly, according to a 2018 Pew Research Center survey (see go.nature.com/2akajas). In the United Kingdom, the time young people spend online has almost doubled over the past decade, the communications-industry regulator, Ofcom, has found (see go.nature.com/2hd0c4p). Parental concerns about media use are rising, too — fuelled by headlines and political pronouncements. On 2 October 2018, Matt Hancock, UK secretary of state for health, issued an urgent warning, saying that the threat to children's mental health from social media is similar to that from sugar to their physical health.

In cases of such significant public concern, it often falls to the

Research Statement

The Development of Synthetic Organic/Organometallic Methods and Future Interests

Recently, a synthetic organic renaissance has changed the way we plan synthetic strategy. Governmental regulations demand cost minimization and reduction of hazardous waste streams. The use of enantiomerically pure drugs in chemotherapy is necessary not only to realize enhanced specificity, but also to avoid possible side-effects cause by the other enantiomer. Furthermore, the elucidation of biological processes through structure activity relationship (SAR) studies depends heavily on organic synthesis to identify clinical compounds and improve pharmacological profiles.

The development of synthetic methods that meet the regulatory and commercial needs of the chemical industry, especially pharmaceutical interests, requires the training of students in organic synthesis. In light of these requirements, my research program concentrates on transition metals as a means of achieving efficient and cost-effective organic synthesis.

The use of transition metals to effect a desired transformation has several advantages over classical organic methods. First of all, metals can effect reactions catalytically ultimately leading to reduced waste and more cost - effective syntheses. Second, enantioselective processes occurring on a metal center containing chiral ligands will afford enantiopure compounds. Finally, the mild and chemoselective reactivity of transition metals allows a more convergent approach to complex organic molecules without the need for cumbersome protection/deprotection strategies. My current projects, and those I envision, develop novel synthetic methodologies using transition metals and examine their scope and limitations, the ultimate goal being the efficient and economical asymmetric synthesis of clinically interesting compounds.

Using the methodological studies described below as a foundation, I envision my program expanding into bioorganometallic chemistry as a method of achieving selective chemical transformations. For example, transition metal-catalyzed processes using ligands capable of molecular recognition should be useful as models for naturally occurring metalloenzymes. The design of peptide and carbohydrate based ligands that will impart selectivity as a result of distinctive molecular associations is an area with enormous potential and I present some of my initial interests toward this end in the last proposal of this section. This represents long - term research interests that will allow my group to use its knowledge of organic and organometallic synthesis to make valuable contributions to the field of bioorganometallic chemistry.

Income-based variation in Sustainable Development Goal interaction networks

Introduction

Many conflicts result from the way people interact with each other and with our planet. Since 1992, a range of global initiatives have emerged to find a more sustainable and equitable solution to these conflicts. In 2015, the United Nations set a 15-year plan, composed of 17 sustainable development goals and 169 associated targets, to promote prosperity for all while protecting our planet. Those goals touch on all aspects of human life and therefore interact in complex ways. These goals do not exist in isolation and synergies and conflicts can emerge from their interactions. For example traditional approaches to increasing agricultural productivity (SDG1) will lead to biodiversity and natural habitat loss therefore affecting our ability to meet SDG15.

The inter-dependencies of SDGs were recognised from their inception, but the effects of actions to achieve one goal on the ability to achieve others were anticipated only recently. Some work helped to highlight how interactions between SDG pairs can be negative or co-beneficial. However, in many instances the statistical approach limited the ability to make inferences relevant for interventions. One particular hurdle to date is the lack of recognition in these analytical approaches that interactions can and will vary depending on the socio-economic characteristics of countries. Accordingly, there is little knowledge of the context of the network emerging from direct and indirect interactions between SDGs and there are no robust inferences of associations between goals. This is important because efforts to meet SDGs in isolation can be counter-productive if they affect other SDGs negatively.

Not all interactions may be negative and investment in some SDGs can have additional benefits on multiple goals. There are also other barriers to SDG implementation, as the status quo on some goals can be advantageous for some groups (vested interests) or indeed desirable (for socioeconomic reasons). Understanding the SDG network can help to find new indirect ways to progress on specific SDGs while avoiding non-SDG barriers. Likewise, identifying indirect positive effects of SDGs on other goals can help define the best governance structures to capitalise on synergies and accelerate progress towards the 2030 targets. Finally, using a robust and unified approach to estimating direct and indirect interactions among goals can help us determine whether those interactions differ among countries, which could also explain diverging views on SDG interlinkages.

Studying the topology and drivers of networks has given us crucial insights about complex systems such as health, ecosystems, financial systems and our societies. Network theory provides analytical tools to determine how such mathematical representations of systems can evolve through time and how they might respond to perturbations. We apply a network approach to the SDGs in order to estimate what we call the sustainome, the system of SDG interactions. The sustainome can be represented as a network, where the vertices are the SDGs (goals or targets) and the edges are relationships between them. We estimate the sustainome the network of interactions at two scales: among the 169 SDG targets and among the 17 SDG themselves. The concept of the sustainome is inspired from the conceptual definition of sustainomics, defined as the study of how to achieve sustainability by maintaining six capitals – infrastructure, finance, communities, people, ecosystems, and biodiversity– while generating the flows we require from those capitals to achieve the SDGs.

Relationships among goals can be defined in a number of ways, from shared concepts in their definitions4 to dependencies in indicator trajectories. Within a sustainome framework, interactions between the SDGs are represented as the associations between progress towards each SDG (see Methods). For example, if initiatives are implemented to increase GDP, will they be associated with a degradation of biodiversity? Several organisations have monitored macroscale indicators associated with the SDGs in most countries over the past decades, which allows us to determine global interactions among the SDGs.

Remember:

Your first draft is ONLY a starting point!!

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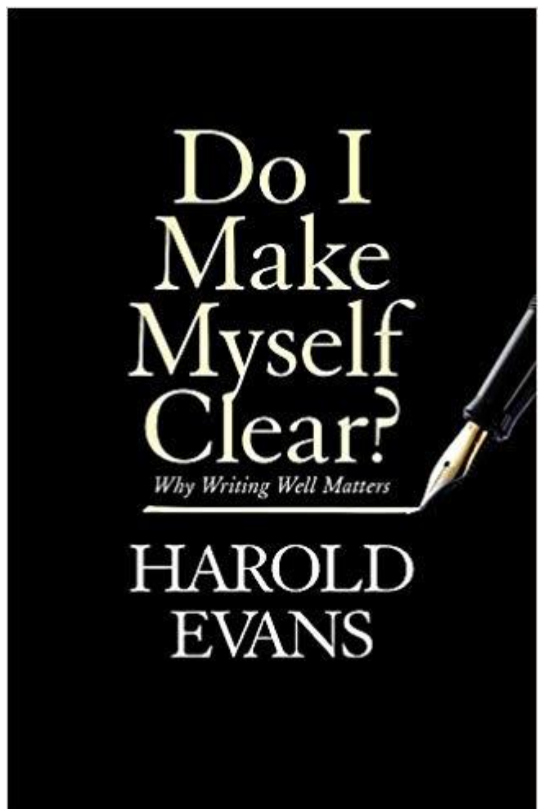
"It’s good to feel bad about something you’ve just written. It tells you there’s a fat chance nobody else will feel good about it either, so you’d better work out what’s wrong and fix it."

Harold Evans



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