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Physics is our playground

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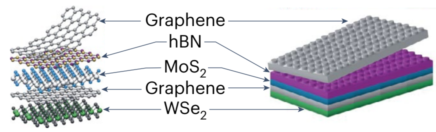
Driven by curiosity and creativity, materials that are diverted from their intended use may lead to surprising insights. We take a moment to celebrate the playful side of physics.

Whether it's sticking halved grapes into a microwave to create a plasma[1] or discovering graphene[2] with a piece of sticky tape as was famously done by Andre Geim and Konstantin Novoselov, playful approaches to physics are more common than one might think. Physics – as it turns out – has a whimsical side.

Geim's overarching approach to research is driven by what he refers to as LEGO® doctrine, "You have all these different pieces and you have to build something based strictly on the pieces you've got"[3]. The name of the iconic colourful plastic building bricks designed by the LEGO Group has long become a synonym for assembling, for example, two-dimensional materials to create van der Waals heterostructures (pictured)[4] or DNA single strands to form complex three-dimensional structures[5]. But what about the iconic brick itself?

Its beginnings lie in a woodworking and carpentry shop (Billund Maskinsnedkeri) in Billund, Denmark bought by Ole Kirk Kristiansen in 1916. The workshop shifted its focus to toy production in 1935. This transition from manufacturing windows and doors to wooden toys was reflected by a change in the company's name from Billund Maskinsnedkeri to the LEGO Group, which is based on *leg godt*, Danish for 'play well'.

Due to the scarcity of high-quality wood supplies in the years following World War II and the rise of new materials and technology, the company began to experiment with the fabrication of plastic toys. In the late 1940s, the LEGO Group released the precursor of today's beloved bricks, called Automatic Binding Bricks. However, the design was not yet perfect. To improve the stability of models built out of the hollow bricks, Ole's son



Godtfred Kirk Christiansen devised an interlocking stud-and-tube design and applied for a patent only a few days after its invention in January 1958. This day is now celebrated as International LEGO® day. When the original patent expired twenty years later, it opened the door for others to manufacture similar building blocks based on the interlocking principle.

The original design allows to combine six bricks measuring 2 × 4 studs in 915,103,765 different ways. Considering all the different types of bricks, the possibilities are endless. Brick enthusiast of all ages have come up with brilliant ideas on how to combine them into models – including science-related ones. As part of a competition by the LEGO Group, geoscientist Ellen Kooijman submitted a proposal for a set depicting women in science, which was eventually made into a research institute kit featuring three female scientists: a palaeontologist, an astronomer and a chemist.

Not only have researchers brought science to official kits, but some scientists have incorporated their passion for the bricks into their outreach or research activities. One example is the Build Your Own Particle Detectors programme, which won the outreach prize of the European Physical Society in 2021. The initiative started off with a model of the ATLAS detector at the Large Hadron Collider, which consists of around 9,500 LEGO® pieces. The bricks have also been used to construct experiments for educational purposes, such as optical microscopes[6], atomic force microscopes[7] and their macroscopic analogues, called dynamic force macroscopes[8].

Another example is a brick-based Michelson interferometer[9], which can be used to determine a laser pointer's wavelength or the refractive index of a glass plate. To demonstrate the principle of a watt balance, which is used to establish the value and associated uncertainty of a mass that is consistent with the definition of the kilogram, a tabletop version built with plastic bricks achieved a 1% relative uncertainty when measuring gram-level masses[10].

Besides these more playful uses, the toy bricks have become low-cost alternatives for optical components, such as tilting tables or mounts for mirrors, lenses and prisms. By adding a few custom-made components, one can even realize most mechanical parts of a typical optical setup[11]. Diagnostic equipment built with plastic bricks, for example a tensile testing device used for studies of stretchable electronics[12], can reach performances comparable to those of commercially available devices. The bricks can even be used to build experimental platforms for the investigation of metamaterials[13].

In the future, scientists will undoubtedly find even more creative ways to use unexpected materials in surprising ways in their outreach and research activities. So let's all go play to get inspired.

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