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LESEPROBE

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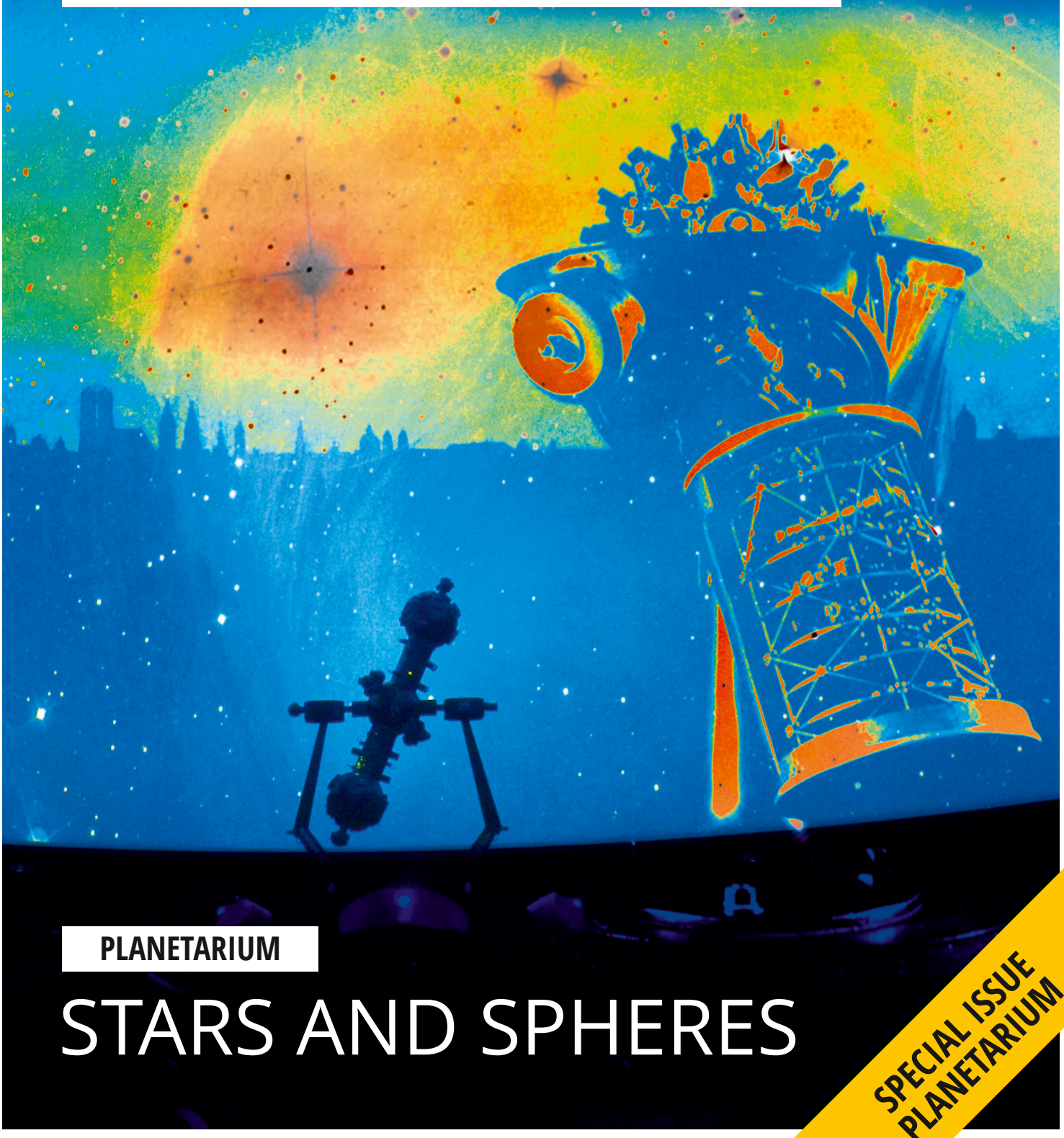
NEW SPACE RACE ZERO HISTORY ROCKET SLING
AERONAUTICS METROLOGY SPACE TECHNOLOGY



PLANETARIUM

STARS AND SPHERES

SPECIAL ISSUE PLANETARIUM

ZKZ 87779 // ISSN 2199-0581

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WRITTEN IN THE STARS

Planetarium heißt auf Englisch *planetarium*. So weit, so einfach. Doch wenn wir tiefer in die englische Sprache eintauchen, stoßen viele von uns irgendwann an eine Grenze. Vokabeln wurden vergessen, die Grammatik ist eingerostet, der Sprachfluss holpert. Genau für diesen Fall haben wir vor fast 10 Jahren INCH, das Sprachlernmagazin für speziell für technisches Englisch, ins Leben gerufen.

INCH wendet sich an alle Ingenieurinnen und Ingenieure, Technikerinnen und Techniker, sowie Technikinteressierte, die ihr Fachenglisch auffrischen oder verbessern möchten. In jedem Heft erwarten Sie fünf große Reportagen zu aktuellen, ungewöhnlichen Themen aus Technik, Wissenschaft und Industrie. Dank der praktischen Vokabelhilfe können Sie in den Artikeln mühelos schmökern.

Wenn Sie dann tiefer einsteigen wollen, finden Sie in INCH zu ausgewählten und relevanten Technik-Themen ausführlich Pictorials, Fachwörterbücher, Technikgrundlagen und viele Übungen, mit denen Sie Ihren technischen Wortschatz vertiefen können.

Der speziell auf den Berufsalltag von Beschäftigten in Industrie und Technik zugeschnittene Sprachteil trainiert den allgemeinen Wortschatz, den Umgang mit Zeiten und wechselnde Grammatik-Schwerpunkte. Praktische Übungen stehen dabei im Vordergrund, die notwendige Theorie ist auf ein Minimum reduziert.

Diese Leseprobe entspricht in Aufbau und Umfang einer regulären Ausgabe von INCH, so dass Sie sich einen Eindruck davon machen können, was Sie alle drei Monate erwartet. Für diese Sonderausgabe haben wir exklusiv für Sie unsere besten Geschichten rund um Planetarium und Raumfahrt zusammengestellt: Lesen Sie über die Geschichte des Planetariums und das neue Weltraumrennen. Erfahren Sie, was Jules Verne und das Apollo-Programm gemeinsam haben und wer der Vater der Science-Fiction ist. Natürlich darf bei uns auch Shakespeare nicht fehlen, der ein ganz besonderes Verhältnis zur Ziffer 0 hatte.

Wir wünschen Ihnen viel Vergnügen beim Schmökern.

Matthias Meier // Chefredakteur & Herausgeber
redaktion@inchbyinch.de

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< COVER: ZEISS >

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STARS & SPHERES

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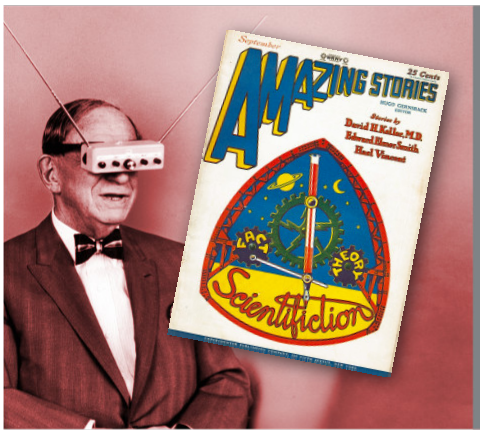
A TALE OF TWO ROCKETS

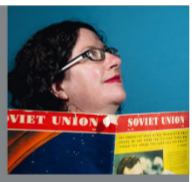
SPACE RACE // Gleich zwei riesige Raketen stehen bereit, um uns wieder zurück zum Mond zu bringen. Doch NASAs Space Launch System und SpaceXs Starship könnten unterschiedlicher nicht sein.



THE AMAZING HUGO

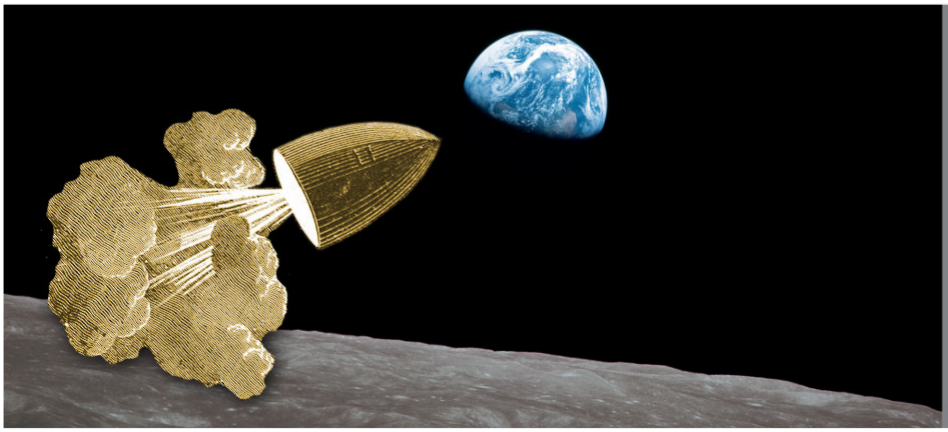
GERNSBACK // Der Verleger Hugo Gernsback wird oft der "Vater der Science-Fiction" genannt, weil er mit seinen vielen Magazinen das Science-Fiction Genre überhaupt erst erschaffen hat, um es dann zu dem zu machen, was wir heute lieben – oder hassen.

INTERVIEW



ALICE GRORMAN

Auch im all hinterlässt die Menschheit ihre Spuren. Die Weltraumarchäologin Alice Gorman setzt das kulturelle Erbe der Weltraumforschung in den historischen Kontext.



FROM THE EARTH TO THE MOON

VERNE vs APOLLO // Der Flug von Apollo 8 machte aus Jules Vernes Roman „Von der Erde zum Mond" Wirklichkeit. Die gewagteste Mission des ganzen Mondprogramms war überraschend nah an Vernes Skript.

< PHOTOS: ZEISS, SPACEX, ALFRED EISENSTAEDT/THE LIFE PICTURE COLLECTION/GETTY IMAGES, FLINDERS UNIVERSITY, NASA, BELINDA FEWINGS/UNSPLASH.COM >

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TECHNICAL ENGLISH
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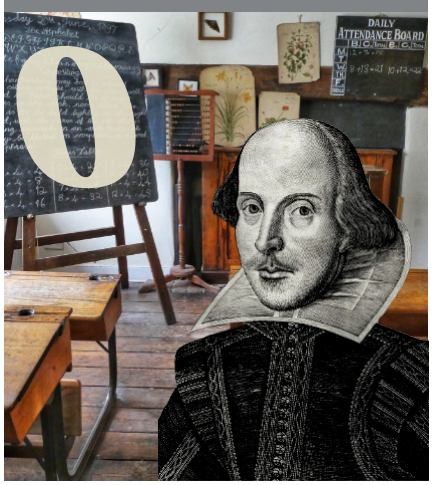
ROCKET SLING

LAB REPORT // Statt mit teuren Raketen will Spinlaunch bald Satelliten einfach mit einer riesigen Hightech Schleuder ins Weltall katapultieren. Ein erster, erfolgreicher Test beweist, dass dies mehr als eine verrückte Idee ist.

DECIPHERING ZERO

HISTORY // Die Null wurde dreimal erfunden, dient zwei Zwecken und ist doch einzigartig. Die magische Ziffer wurde vergessen, gefürchtet, verboten und geheim gehalten. Doch was genau ist die Null – und was hat Shakespeare mit ihr zu tun?



SPECIAL ISSUE // PLANETARIUM

ENGINEERING

BUSINESS

LANGUAGE

< PHOTO: VALKYRIE RACING >

POLAR PORSCHE

After having raced her classic 1956 Porsche 356 A on six continents, Renée Brinkerhoff is now off to the final stage of her Project 356 World Rally Tour: Antarctica. The 65-year-old amateur rally driver is on a mission to *raise awareness* and collect money for women and children at risk, with a special focus on ending *child trafficking*. The final leg of her journey is certainly spectacular enough to draw some attention: 587 kilometres across Antarctica's snow and ice towards the south pole. To survive the trip, however, the *vintage* Porsche needed a few modifications.

The team replaced the rear tyres of the vehicle with *snow tracks*, and a pair of skis were *attached* to the front along with a specialised *suspension* system. If necessary, tracks and skis can easily be removed and replaced by *spiked* ice tyres. Thanks to an additional *crevasse* bar at the front the *mean* machine can cross up to 2-meter-wide ice *gaps*.

www.valkyrieracing.com/donate356

RIDING A VENTURI TUBE

From the side, the WMC250EV motorcycle looks like any other sports bike covered in *fairings* but wait until it turns. Viewed from the front or back, there seems to be something missing – a lot actually: The designers have *punched* a big hole right through the motorcycle. The rider is basically *straddling* a tube to which all the other components including wheels, all-electric drivetrain and batteries are *attached*. The V-Air system, which *derives* its name and its basic principle from the Venturi effect, is *supposed to* reduce the bike's *drag* by almost 70 percent compared to a high-performance bike.

White Motorcycle Concepts hopes that this in combination with 250 kW of power and a unique two-wheel drive will be enough to go beyond the 400 kph barrier and *smash* a few speed records, starting with the British land speed record in 2022.

https://whitemotorcycleconcepts.com/v-air-technology


< PHOTO: WMC >

BINARY BABIES

< PHOTO: CHASE ROBERTS >

When should you begin with the *STEM* education of your kids? How about when they are still babies? We are not talking about building bricks or *peg*-in-the-hole toys designed to *enhance* motor *skills*. This is about proper 'computer engineering for babies'. That's the actual title of a *board book*, which is "designed to keep your baby *engaged* while they learn about the stuff that computers are made from," as the developer Chase Roberts describes it.

The book has two buttons and an LED. Depending on which page you are there is a different *logic gate*: WIRE, NOT, OR, AND, XOR or LATCH. The young *nappy* hackers will certainly love to endlessly push the buttons. But why should they learn to divide the world into zeros and ones before they even begin to explore its analogue wonders?

https://computerengineeringforbabies.com

< PHOTO: WILLIAM RODERICK >

What do you get when you cross a *raptor* with a quadrocopter? SNAG, short for stereotyped nature-inspired aerial *grasper*, is a drone that has a pair of 3D-printed legs *attached* to it which were inspired by a *peregrine falcon* – including *tendons* and big, *mean*-looking *talons*. This isn't some Hollywood *prop* but a serious research project *exploring* the ways birds grab *branches* and transferring the mechanics to drones.

The purely mechanical *clawing* mechanism allows drones to *perch* almost everywhere. In the future, drones with legs could 'rest' on a tree or a wall instead of *hovering* while waiting for their next *assignment*. Or they could grab objects or even *snatch* other drones out of the sky, just like trained eagles at airports already do.

https://news.stanford.edu/2021/12/01/bird-like-robot-perches-grasps/

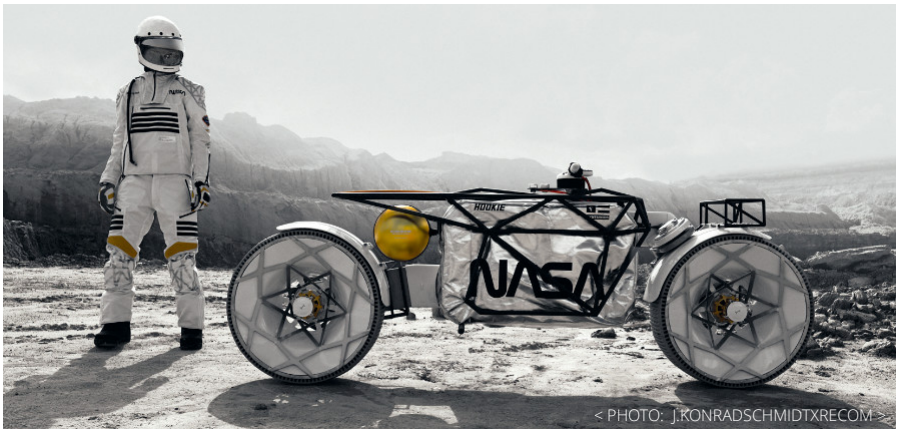
MOONCYCLE

There's a lot of talk about going back to the moon towards the middle of the 2020s but at closer look all the concepts seem to be little more than a *scaled-up* copy of our *previous efforts*, basically Apollo *on steroids*. Here's a novel idea from the German motorbike design think tank Hookie: a moon motorcycle.

Tadigrade, as it's called, started off as a digital art sketch which, over the course of just nine months, has been turned into a working prototype. The design is simple: Two single-sided swing arms with airless tires are *attached* to an aluminium frame. The electric drivetrain is protected from the cold and radiation in space by a Kevlar cover. Astro-bikers can expect a top speed of 15 kph and a *range* of 110 kilometres. Of course, it's only a concept at the moment but a very inspiring one. Imagine a *crackling* voice from the moon speaking those iconic words: "Houston, we have a wheelie."

www.hookie-tardigrade.co

assignment	*Auftrag, Einsatz*
attach, to // ə'tætʃ	*befestigen, montieren*
board book	*Pappebuch*
branch // brɑ:ntʃ	*Zweig, Ast*
child trafficking	*Kinderhandel*
claw, to	*krallen*
crackle, to	*knacken, prasseln, knistern*
crevasse // krə'væs	*Gletscherspalte*
derive, to // dɪ'raɪv	*ableiten, sich herleiten*
drag // dræg	*(Luft-) Widerstand*
effort	*Versuch, Anstrengung*
engage, to // ɪn'geɪdʒ	*beschäftigen, motivieren*
enhance, to // ɪn'hɑ:ns	*verbessern, fördern*
explore, to	*erkunden, erforschen*
fairing	*Verkleidung*
gap // gæp	*Spalte, Kluft, Lücke*
grasper	*Greifer*
hover, to	*schweben*
logic gate	*Logikgatter*
mean	*fies, gemein*
nappy	*Windel*
on steroids // ɒn 'sterɔɪds	*etwa: auf Speed/Droge*
peg	*Stift, Pflock, Zapfen, Stöpsel*
perch, to // pɜ:tʃ	*sitzen, hocken*
peregrine falcon // 'perɪgrɪn	*Wanderfalke*
previous // 'pri:viəs	*vorhergehende/r/s, frühere/r/s*
prop	*hier: Requisite*
punch, to	*stanzen, schlagen*
raise awareness, to (rose, risen)	*Bewusstsein schärfen*
range // reɪndʒ	*Reichweite, Aktionsradius*
raptor	*Raubvogel*
scale-up, to	*hochskalieren, vergrößern*
skill	*Fähigkeit, Können*
smash, to	*zerschlagen, zerschmettern*
snatch, to	*schnappen, erhaschen*
snow track	*Schneeraupe*
spiked	*mit Spikes versehen*
STEM (science, technology, engineering, mathematics)	*MINT (Mathematik, Informatik, Naturwissenschaft & Technik)*
straddle, to	*spreizen, grätschen*
supposed to, to be	*sollen*
suspension	*Aufhängung, Federung*
talon // 'tælən	*Kralle, Fang*
tendon	*Sehne*
vintage // 'vɪntɪdʒ	*alt, klassisch*



< PHOTO: J.KONRADSCHMIDTXRECOM >

Planetarien mit ihren charakteristischen, hantelförmigen Projektoren in der Mitte hätten beinahe ganz anders ausgesehen: Als Oskar von Miller, der Gründer des Deutschen Museums, und Zeiss einst ein modernes Planetarium planten, dachten sie anfangs über riesige, gelochte Hohlkugeln und Schwermechanik nach. Zum Glück hat ein brillanter Ingenieur das Problem wortwörtlich ins rechte Licht gerückt. Dies ist die Geschichte, wie die Sterne in die Kuppel kamen.

< PHOTOS: ZEISS >

STARS AND SPHERES

Planetariums, with their characteristic dumbbell-*shaped projector in the middle, could have looked quite different: When Oscar von Miller,* founder *of the 'Deutsches Museum', and Zeiss first thought about building a modern planetarium they considered a giant, perforated metal* sphere *and* heavy-duty *mechanics. Luckily, a brilliant engineer shone, quite literally, the right light on the problem. This is a story about starlight and spheres.*

"We kindly inform you that we can't be *concerned* with the manufacture of a planetarium since this kind of work is not within the *scope* of our production." Such a clear *rejection* seems *odd*, given that it came from a company that, today, is basically synonymous with planetarium projectors: Zeiss.

But the year was 1913 and Oskar von Miller, the founder of the Deutsches Museum in Munich, wasn't asking Zeiss for a projector – he had something completely different in mind: a giant metal sphere with holes for stars. The 10-metre *behemoth* would be *supported* by enormous *ball bearings* so that visitors could enter the *contraption* through its *tilted* axis. No wonder Zeiss, well known for its precision equipment, turned him down. The planetarium as we know it today almost didn't happen.

HEAVENLY MECHANICS

Ever since *stargazers* realized that the *motion* of the stars and the planets *adhered* to strict mechanical principles, they felt the *urge* to replicate these movements. One of the earliest *attempts* is probably the *astrolabe*. *Invented* by the *ancient* Greeks and *refined* by the Arabs, the 'computer of the *Middle Ages*' was, among many other things, used to tell the time at night. At its *core* the astrolabe is a sextant-like *targeting device* with a rotatable star-*chart*. *Admittedly* you need a bit of imagination to recognize a projected *celestial* sphere in the *squiggly* lines on its disc and a star chart in its ornamental *rete*. Although later models included simple mechanics for the movement of the moon, most astrolabes simply reproduced the motion of the stars.

The first device portraying the movement of the planets was the Antikythera mechanism (see Inch 04 | Diving into History). *Consisting of* some 30 *gearwheels* the highly complex mechanism is one of the wonders of the ancient world – not least because it *predates* the *heyday* of the *comparatively* simple astrolabe by over a thousand years. In 1901, *divers* found some highly corroded bronze fragments off the coast of the Greek island of Antikythera. As it turned out, these fragments belonged to an over 2,000-year-old device which was designed to *predict* the position of the sun, the moon and all the five planets known at the time. It was the first true planetarium.

The Antikythera mechanism, however, remained an historic *oddity*. Nothing *comparable emerged* until, around 1700, European clockmakers began building mechanical models of

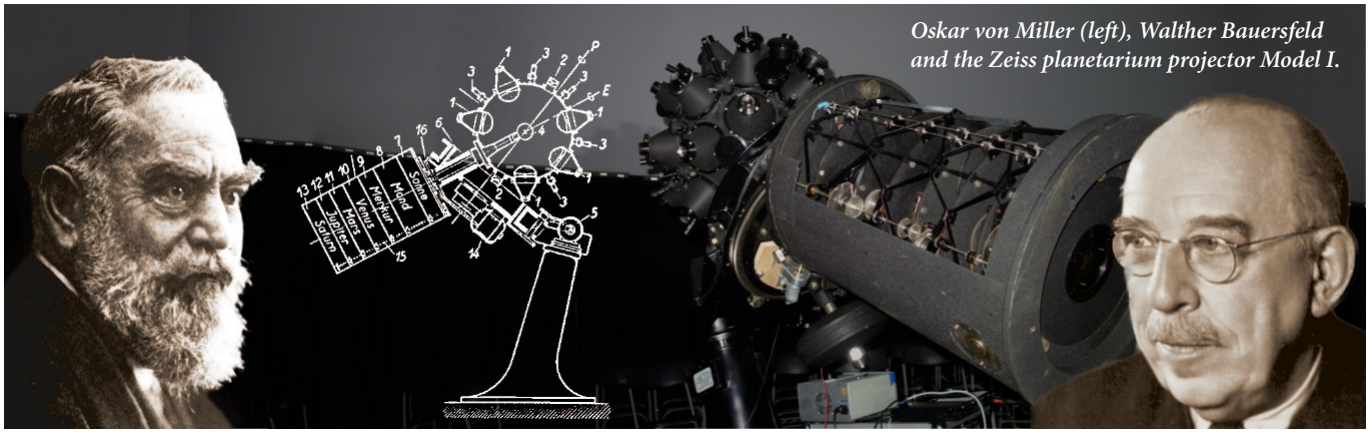
the solar system. Called orreries after Charles Boyle, the Earl of Orrery, they *featured* a *brass* sphere as the sun in the middle around which small *beads* representing the planets and, sometimes, their moons rotated. While the orreries' *intricate* gearworks more or less precisely replicated the relation of the planets' *orbital periods*, they weren't entirely accurate models of the solar system since the sizes of planets and their orbits are almost impossible to scale *sensibly*.

One of the most *unique* orreries is found in the city of Franeker in the Netherlands. From 1774 to 1781, Eise Eisinga, a *wool comber* and amateur astronomer, built a giant orrery, which he mounted to the ceiling of the living room in his small house. *Reportedly* he built the planetarium to educate his *fellow citizens*, who were afraid that an upcoming *conjunction* of several planets would cause *doom* and destruction. The beautiful orrery still exists and is the oldest working public planetarium in the world.

A WALK-IN NIGHT SKY

Oscar von Miller had something similar in mind when he was planning the astronomy *department* of the "German Museum for Masterpieces of Natural Science and Technology" in Munich. From 1903 onwards, the electrical engineer *promoted* his *novel* concept of a museum where visitors could learn about science and technology through *hands-on experiences*. By 1924 the huge complex on a small island in the Isar river was taking shape and its first planetarium was opened to the public. >>>

adhere, to // əd'hɪə	*sich halten, befolgen*
admittedly	*zugegebenermaßen, freilich*
ancient // 'eɪnʃənt	*alt, antik*
astrolabe // 'æstrəleɪb	*Astrolabium*
attempt	*Versuch, Bemühung*
ball bearing // ˌbɔːl 'beərɪŋ	*Kugellager*
bead	*Perle, Kügelchen*
behemoth // bɪ'hiːməθ	*Ungetüm, Koloss*
brass // brɑːs	*Messing*
celestial // sə'lestiəl	*himmlisch*
chart	*Karte*
comparable // 'kɒmpərəbl	*vergleichbar*
comparatively // kəm'pærətɪvli	*vergleichsweise, relativ*
concern, to // kən'sɜːn	*beschäftigen, interessieren*
conjunction // kən'dʒʌŋkʃn	*Konjunktion*
consist of, to	*bestehen aus*
contraption	*Vorrichtung, komisches Gerät*
core	*Kern, Innerstes*
department	*Abteilung*
device // dɪ'vaɪs	*Gerät, Apparat*
diver	*Taucher/in*
doom // duːm	*Untergang, Unheil, Verderben*
dumbbell	*Hantel*
emerge, to // ɪ'mɜːdʒ	*auftauchen, entstehen*
experience // ɪk'spɪəriəns	*Erfahrung, Erleben*
feature, to	*aufweisen, ausgestattet sein*
fellow citizen	*Mitbürger/in*
founder	*Gründer/in*
gearwheel // 'gɪəwiːl	*Zahnrad*
hands-on	*interaktiv, praxisorientiert*
heavy-duty	*Schwer-, strapazierfähig*
heyday	*Blütezeit, Hochphase*
intricate	*kompliziert, raffiniert*
invent, to	*erfinden, ausdenken*
Middle Ages	*Mittelalter*
motion // 'məʊʃn	*Bewegung, Lauf*
novel // 'nɒvl	*neuartig, neu*
odd	*seltsam, verwunderlich*
oddity // 'ɒdəti	*Kuriosität, Kuriosum*
orbital period	*Umlaufzeit*
predate, to	*vorausgehen*
predict, to	*vorhersagen, vorausberechnen*
promote, to	*sich einsetzen für, vorantreiben*
refine, to	*verbessern, weiterentwickeln*
rejection // rɪ'dʒekʃn	*Absage, Abfuhr*
reportedly // rɪ'pɔːtɪdli	*angeblich, Berichten zufolge*
rete // 'riːtiː	*Rete*
scope	*Rahmen, Bereich,*
sensibly	*vernünftig, sinnvoll*
sphere // sfɪə	*Kugel*
squiggly // 'skwɪgli	*verschnörkelt*
stargazer // 'stɑːgeɪzə	*Sterngucker/in*
support, to	*lagern, tragen*
target, to	*anpeilen, anvisieren*
tilt, to	*neigen, kippen*
unique // juː'niːk	*einzigartig, einmalig*
urge // ɜːdʒ	*Drang, Verlangen*
wool comber // wʊl kəʊmə	*Wollkämmer*



Oskar von Miller (left), Walther Bauersfeld and the Zeiss planetarium projector Model I.

< PHOTOS: DEUTSCHES MUSEUM, MATTHIAS MEIER, ZEISS >

Top: An astrolabe and the Grand Orrery in the 'Deutsches Museum'. Left: The 2.000-year-old Antikythera mechanism. Right: Eise Esinga's planetarium from 1781 in the Netherlands is still open to the public.

Similar to Eisinga's orrery, the museum's heliocentric or Copernican planetarium was mounted to the ceiling of a hall. In its centre was a large light ball representing the sun. The planets, which *dangled* from little *carriages* running on 'orbital' *rails*, could even move up and down to simulate the *inclination* of their orbits. Visitors were welcome to freely *stroll* around this miniature solar system or even hop on a little *trolley* representing the Earth. By *peering* through a periscope, they could observe the planetary dance and get their heads around phenomena such as the *apparent retrograde* motion of the planets.

This was all very impressive and *educational* but von Miller wanted more. In the Copernican planetarium the stars were fixed and reduced to a band around the walls *depicting* the constellations of the *zodiac*. Von Miller *envisioned* a second, so-called Ptolemaic planetarium which would show the stars as we see them in the night sky: with the viewer in the centre and the celestial globe *seemingly* rotating around them. *Hence* his plan to build a giant perforated metal sphere.

The idea wasn't exactly new. In the middle of the 17th century, walk-in celestial globes almost became somewhat of a fashion. One was constructed at Gottorf Castle near Schleswig, another was built by mathematician Erhard Weigel atop the city palace in Jena. A more *recent* example is the Atwood Celestial Sphere of Chicago's Adler Planetarium from 1913, which is still in operation.

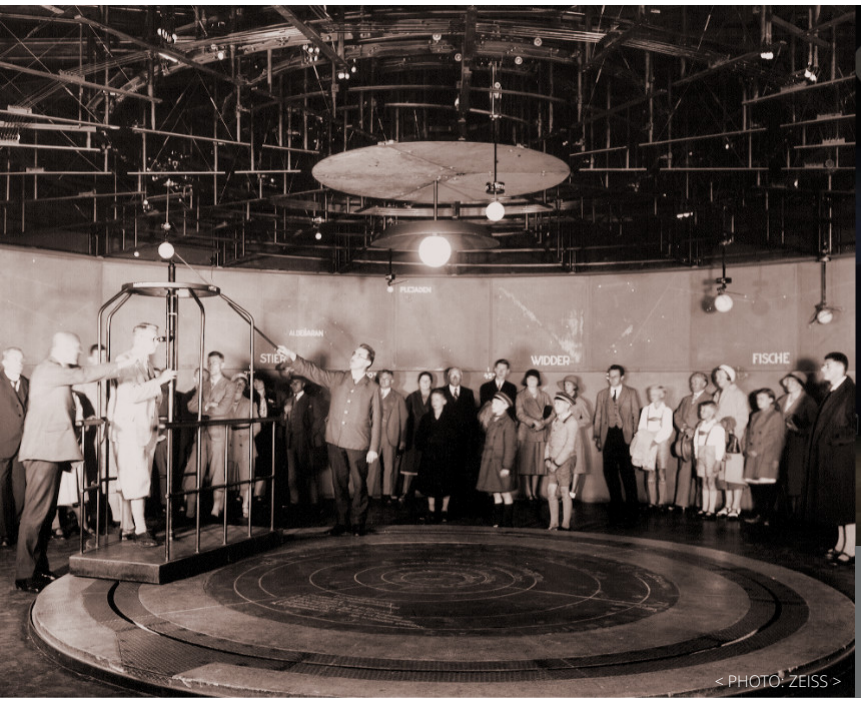
Most likely *unbeknownst* to von Miller the American sphere was exactly what he had in mind – except that he also wanted to add rails or some sort of mechanics to include the movement of the planets in the presentation. Who would be better *suited* to build such complex mechanics than experts in precision equipment? But Zeiss turned him down.

LET THERE BE LIGHT

Luckily, von Miller was a *persistent* man. He kept on *bugging* Zeiss about big metal spheres and little mechanical planets until one of the engineers in Jena, Walther Bauersfeld, *suggested* replacing any *rickety* planetary rails or *pointers* with a simple projection of the planets. Now *the penny dropped*: Why not project the stars as well! What, on the 24th February, 1913, started as just another *dreary* business meeting became the birth of the optical planetarium as we know it. It's one of those ideas that, once they are out, seem almost too simple to have been overlooked for so long: When the stars and planets were all projected from a central instrument, the *ungainly* rotatable sphere became a simple projection *dome*.

Optics and precision mechanics – finally Zeiss was in familiar terrain. Still, *delayed* by a 'great war', internal *struggles* and lots and lots of problem *solving*, it took Bauersfeld over ten years to turn his *flash of inspiration* into a working projector. Simply called 'Model 1', it consisted of two main parts: a sphere with dozens of small projectors for the stars and the *Milky Way* and a cylinder which *housed* the mechanics for the projection of the planets, the sun and the moon.

The sphere, with its central 500-Watt *bulb*, is actually an *icosahedron* with cut-off *vertices* – which sounds *rather* complicated but is simply the shape of a classic black-and-white football. This *provided* the necessary space for 31 lenses each with its own separate star field '*slide*' and eleven projectors for the Milky Way. Additional, smaller projectors in between could be *switched* on to show the constellations and star



< PHOTO: ZEISS >

< PHOTO: ADLER PLANETARIUM >

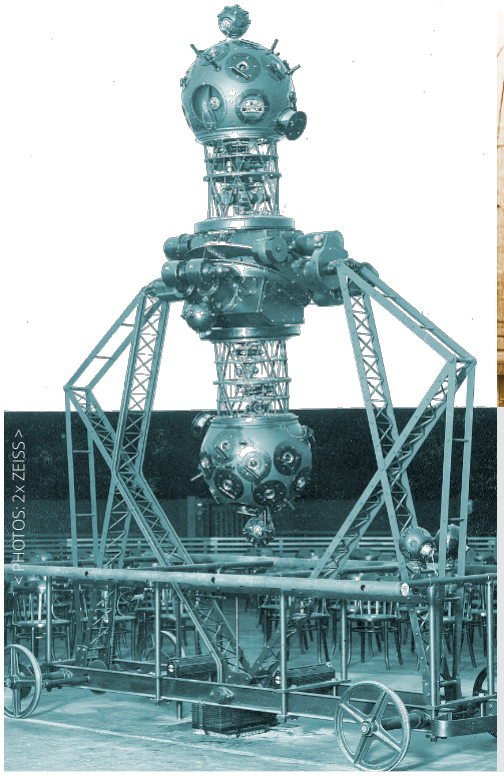
Oskar von Miller had two planetariums planned for the 'Deutsches Museum': A Copernican planetarium (left) and a giant metal sphere with holes for stars similar to the Atwood Celestial Sphere of Chicago's Adler Planetarium (top).

names. While the sphere was certainly an optical *marvel* the cylinder was even more complex. Each of the planetary mechanics for Mercury, Venus, Mars, Jupiter and Saturn was basically a small orrery with two *disks* for the earth and the planet. To recreate the geocentric viewpoint, the orrery's 'earth' was connected to the planet via a *sliding link*, so that the projector at the end of this link would always point in the direction where we on earth would see this planet. The whole *assembly* of cylinder and sphere could be rotated around a *common* axis to simulate the nightly movement of the stars and tilted to recreate seasonal changes.

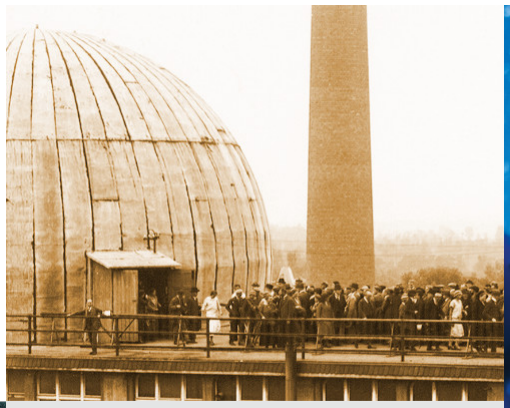
THE *MIRACLE* IN JENA

Von Miller was so *itching* to finally get his hands on the new projector that he ordered the unfinished, *barely* working Model 1 to be shown to a selected *audience* in Munich >>>

apparent	*scheinbar, anscheinend*
assembly	*Baugruppe, Aufbau*
audience // 'ɔ:diəns	*Zuschauer, Publikum*
barely	*kaum, gerade so*
bug, to	*nerven, auf den Wecker fallen*
bulb	*(Glüh-) Birne*
carriage // 'kærɪdʒ	*Wagen, Schlitten, Laufwagen*
common	*gemeinsam*
dangle, to	*herabhängen, baumeln*
delay, to	*verspäten, verzögern*
depict, to	*abbilden, darstellen*
disk	*Scheibe*
dome	*Kuppel*
dreary // 'drɪəri	*öde, trostlos, eintönig*
the Penny dropped	*der Groschen ist gefallen*
educational	*lehrreich, bildend*
envision, to	*sich vorstellen, ausmalen*
flash of inspiration	*Geistesblitz*
hence // hens	*daher, infolgedessen*
house, to	*aufnehmen, beherrbergen*
icosahedron // ˌaɪkɔsə'hi:drən	*Zwanzigflächner, Isokaeder*
inclination	*Neigung, Bahnneigung*
itch, to // ɪtʃ	*hier: darauf brennen, ungeduldig sein*
link	*Verbindung, Bindeglied*
marvel	*Wunderwerk*
Milky Way	*Milchstraße*
miracle	*Wunder*
peer, to	*gucken, spähen*
persistent	*hartnäckig, beharrlich*
pointer	*Zeiger, Zeigestab*
provide, to	*bieten, liefern*
rail	*Schiene*
rather	*ziemlich, recht*
recent // 'ri:snt	*neu, modern, jüngst, neulich*
retrograde // 'retrəgreɪd	*rückläufig, rückgängig*
rickety	*klapprig, wackelig*
seemingly	*scheinbar, vermeintlich*
slide	*hier: Dia, Folie*
slide, to	*schieben, gleiten, rutschen*
solve, to	*lösen, klären*
stroll, to	*schlendern, wandeln*
struggle	*Kampf, Gerangel*
suggest, to // sə'dʒest	*vorschlagen, anregen*
suit, to	*sich eignen, passen*
switch, to	*schalten, umschalten*
trolley	*Rollwagen, Karren*
unbeknownst // ˌʌnbɪ'nəʊn	*unbekannt, ohne Wissen*
ungainly // ʌn'geɪnli	*plump, schwerfällig*
vertex (pl. vertices) // 'vɜ:teks ('vɜ:tɪsi:z)	*Ecke, Spitze, Knoten*
zodiac // 'zəʊdiæk	*Tierkreis*



< PHOTOS: 2x ZEISS >



Top: Long queues formed when Zeiss installed a makeshift planetarium on the roof of their factory. It became known as the 'Miracle in Jena'.

Left: While Model I was only capable of projecting the northern hemisphere, its successor, Model II from 1926, sported the iconic dumbbell shape for the whole night sky.

Right: One of the Milky Way 'slides' of Munich's sister Model I, which has been lovingly restored.

< PHOTO: MATTHIAS MEIER >

for a couple of months in 1923. After that it was sent back to Jena for *completion*, where the Zeiss engineers couldn't help but present the Munich projector and its sister model in their own dome on the factory's *rooftop*. These *makeshift* planetarium shows became a huge hit and before long large *queues* could be seen on the roof of the Zeiss plant.

It's hard for us to imagine how *overwhelmed* the people back then must have felt when, for the first time in history, they stepped from bright daylight into a giant *concrete* sphere, which in itself was a *novelty*, where a perfect night sky, almost *indistinguishable* from the real thing, emerged slowly as the eyes adapted. Soon the planetarium became known as 'the miracle in Jena'.

Von Miller was not amused. After all he was the *contracting authority* and naturally wanted miracles of any sort to happen in Munich. And so, on the 7th May, 1925, the world's first modern planetarium opened to the public in the Deutsches Museum.

Munich's time in the spotlight, however, was *brief*. It didn't take Zeiss long to realise that they were on to something and that their planetarium projector was a rather unique and highly *marketable* product. Soon a real 'planetarium *craze*' started among *major* cities in Germany and around the world: Wuppertal, Leipzig, Düsseldorf, Jena, Dresden and Berlin opened their own planetariums just a year later. Vienna followed in 1927, Moscow in 1929 and Chicago in 1930 to name just a few others. By then Bauersfeld had perfected his projector: Model II could rotate freely and had two projection spheres for both the Northern and Southern hemisphere – which gave it that now so iconic barbell shape.

Almost 100 years later the optical planetarium has become a common sight and a *fixed staple* for natural history museums around the world. Most of us have visited one, most likely with a Zeiss projector in the middle that, *despite* modern optics and high-power LED lights, still *maintains* that classical shape and Bauersfeld's initial design principles.

In a planetarium everybody can travel through space. But there is one that's not just a 'spaceship' but a true time machine as well: In a small planetarium in Bruchhausen-Vilsen south of Bremen, an original Model I, in fact Munich's sister projector, is still in operation. It's the closest you can get to the awe people must have felt when they first *experienced* the 'miracle in Jena'. *<<< Matthias Meier >>>*

brief	*kurz, flüchtig*
completion	*Fertigstellung, Komplettierung*
concrete // 'kɒŋkri:t	*Beton*
contracting authority	*Auftraggeber/in*
craze // kreɪz	*Begeisterung, Wahn, Welle*
despite	*trotz, ungeachtet*
experience, to // ɪk'spɪəriəns	*erleben, erfahren*
fixed staple // 'steɪpl	*fester Bestandteil*
indistinguishable // ˌɪndɪ'stɪŋgwɪʃəbl	*nicht zu unterscheiden*
maintain, to	*bewahren, erhalten*
major	*groß, bedeutend*
makeshift	*provisorisch, vorübergehend*
marketable	*vermarktbar, gut verkäuflich*
novelty	*Neuheit, Novum*
overwhelm, to // ˌəʊvə'welm	*überwältigen, übermannen*
queue // kju:	*(Warte-) Schlange*
rooftop	*Dachterrasse, Hausdach*

www.zeiss.de/planetariums/produkte/planetariumstechnik/sternprojektoren.html
Selbst die aktuell von Zeiss angebotenen Sternenprojektoren orientieren sich immer noch an den Konstruktionsprinzipien von Walther Bauersfeld.

www.planetarium-friesland.nl
www.adlerplanetarium.org/explore/exhibits/historic-atwood-sphere
Webseiten des Orrery von Eise Eisinga und der gelochten Atwood Kugel im Adler Planetarium in Chicago – beide historische Vorläufer des heutigen Planetariums.

www.planetarium-bruchhausen-vilsen.de
Im Planetarium Bruchausen-Vilsen ist einer der beiden Original Zeiss Model I Projektoren in Funktion zu sehen.

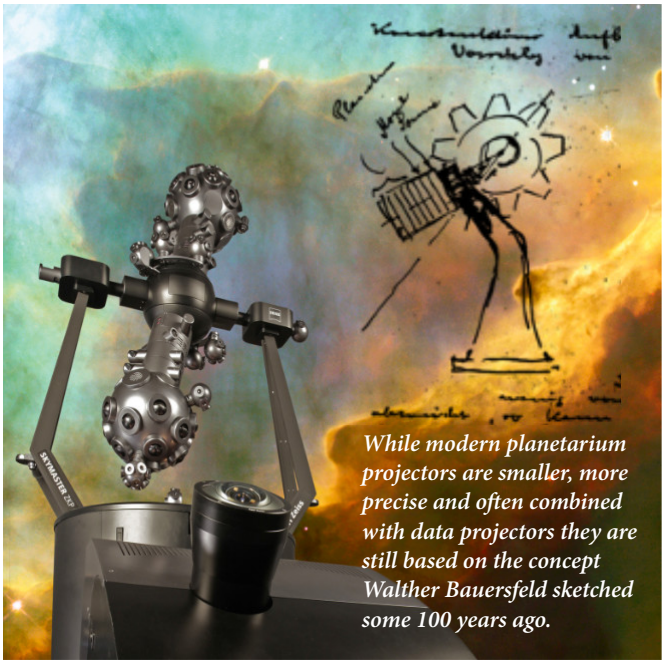
www.gdp-planetarium.org
Auf der Webseite der Gesellschaft deutschsprachiger Planetarien findet sich eine Liste aller Planetarien und Infos zur Geschichte des Planetariums.

www.deutsches-museum.de/museumsinsel/programm/programm-a-z/die-geschichte-des-planetariums
Webseite des Deutschen Museums zum ersten Projektionsplanetarium der Welt.

www.planetarium100.org
Webseite zum nahenden 100-jährigen Jubiläum des Planetariumprojektors.

www.planetarium-jena.de
Das Zeiss-Planetarium Jena von 1926 ist das älteste, noch in Betrieb befindliche Planetarium der Welt.

www.sternwarte.org/ueberuns
Auf der Robert-Mayer-Sternwarte in Heilbronn gibt es einen Hohlglobus mit Bohrlöchern, der in seinem Konzept dem von Oskar von Miller ursprünglich angedachtem Planetarium gleicht.

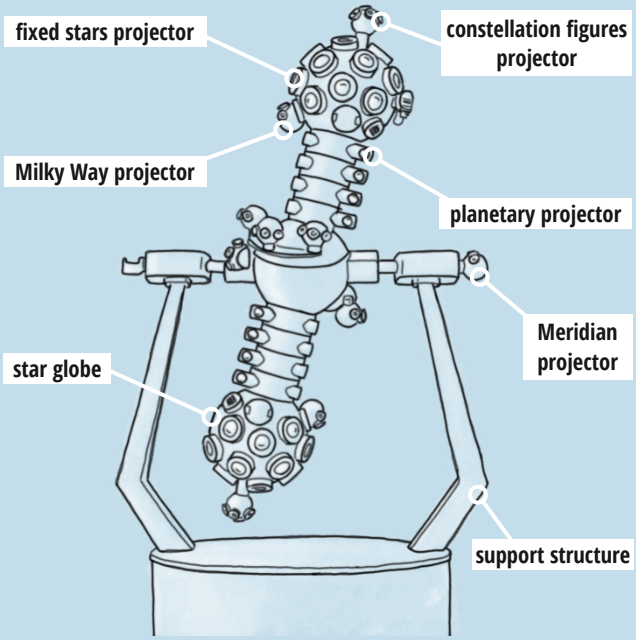


< PHOTO: ZEISS >

Links, Vokabeln & mehr unter
www.inchbyinch.de/inch33/planetarium

TECH EXTRAS

PICTORIAL **PLANETARIUM PROJECTOR**



MINI DICTIONARY **OPTICS**

angular dispersion	*Winkeldispersion*
biconvex	*bikonvex*
chromatic aberration	*chromatische Aberration*
crown glass	*Kronglas*
diffraction grating	*Beugungsgitter*
exit pupil	*Austrittspupille*
flint glass	*Flintglas*
focal length	*Brennweite*
geometrical optics	*Strahlenoptik*
hyperopic	*weitsichtig*
iris diaphragm	*Irisblende*
lens diameter	*Objektivdurchmesser*
myopic	*kurzsichtig*
numerical aperture	*numerische Apertur*
ocular	*Okular*
optical path	*optische Weglänge*
periscope	*Periskop*
polariser	*Polarisationsfilter*
refraction	*Lichtbrechung*
reverse reading	*seitenverkehrt*
slide	*Dia*
speed of light	*Lichtgeschwindigkeit*
tube lens	*Tubuslinse*
underexposure	*Unterbelichtung*
zoom lens	*Zoomobjektiv*

ASTROLABIUM BAUSATZ

Entwurf: Martin Brunold (www.astrolabe.ch)

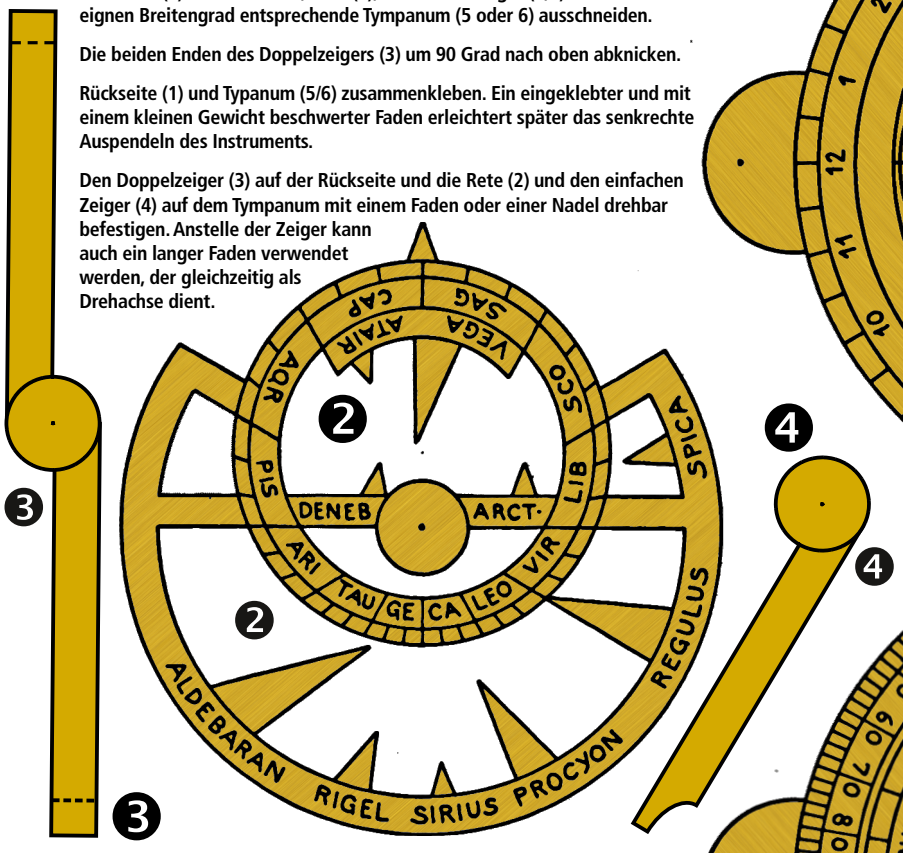
Bauanleitung

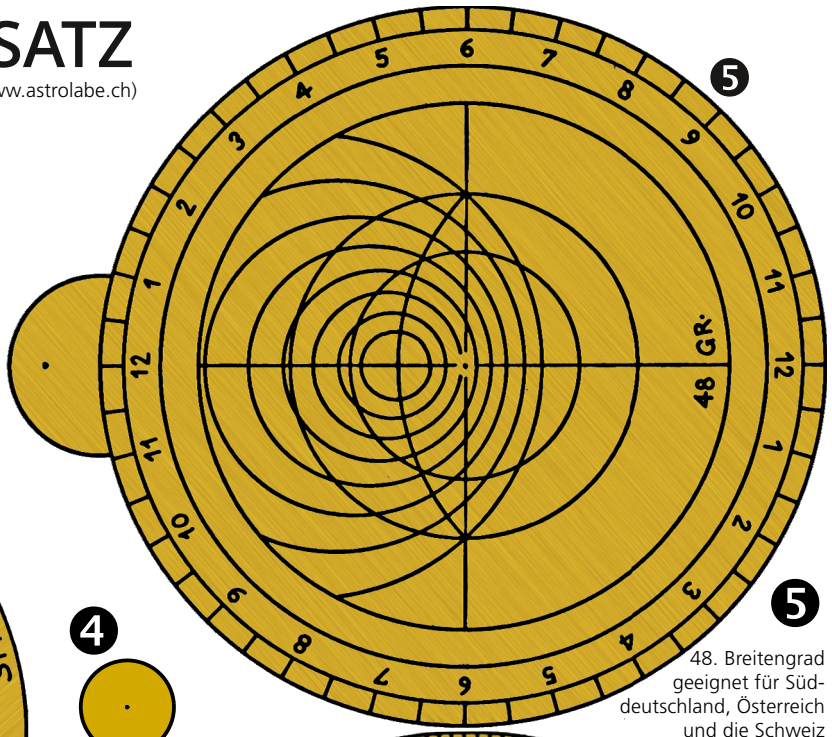
Rückseite (1) mit Gradskala, Rete (2), die beiden Zeiger (3,4) und das dem eignen Breitengrad entsprechende Tympanum (5 oder 6) ausschneiden.

Die beiden Enden des Doppelzeigers (3) um 90 Grad nach oben abknicken.

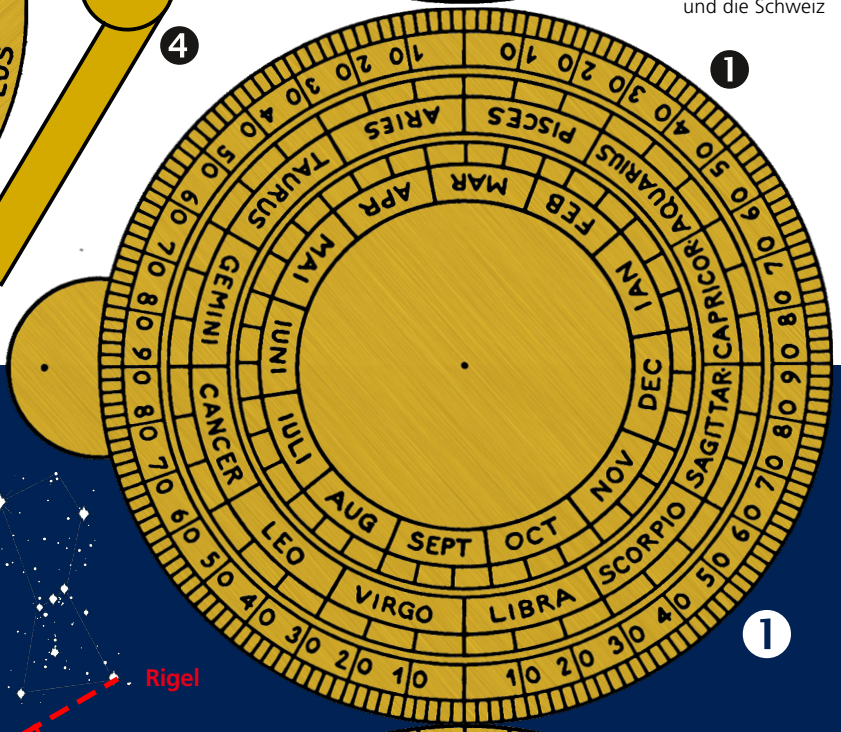
Rückseite (1) und Typanum (5/6) zusammenkleben. Ein eingeklebter und mit einem kleinen Gewicht beschwerter Faden erleichtert später das senkrechte Auspendeln des Instruments.

Den Doppelzeiger (3) auf der Rückseite und die Rete (2) und den einfachen Zeiger (4) auf dem Tympanum mit einem Faden oder einer Nadel drehbar befestigen. Anstelle der Zeiger kann auch ein langer Faden verwendet werden, der gleichzeitig als Drehachse dient.





48. Breitengrad geeignet für Süddeutschland, Österreich und die Schweiz

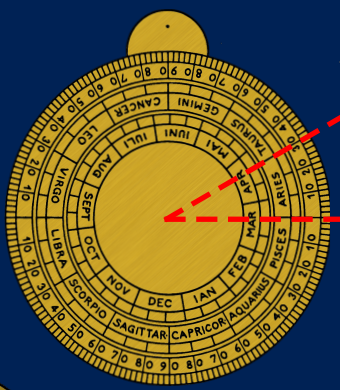


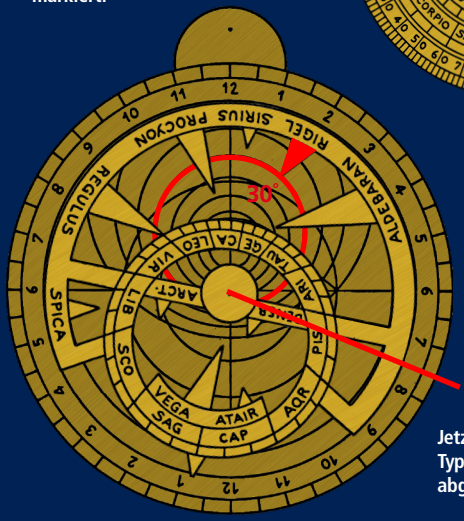
Bedienungsanleitung

Astrolabium senkrecht halten und einen der auf der Rete angegebenen Sterne anpeilen (z. B. Rigel). Astronomisch Unerfahrenen helfen Online Sternkarten (z. B.: www.astroviewer.de/interaktive-sternenkarte.php) oder eine Planetariumssoftware (z. B. www.stellarium.org) bei der Sternsuche.

Auf der Gradskala der Rückseite die Höhe des Sterns über dem Horizont ablesen.

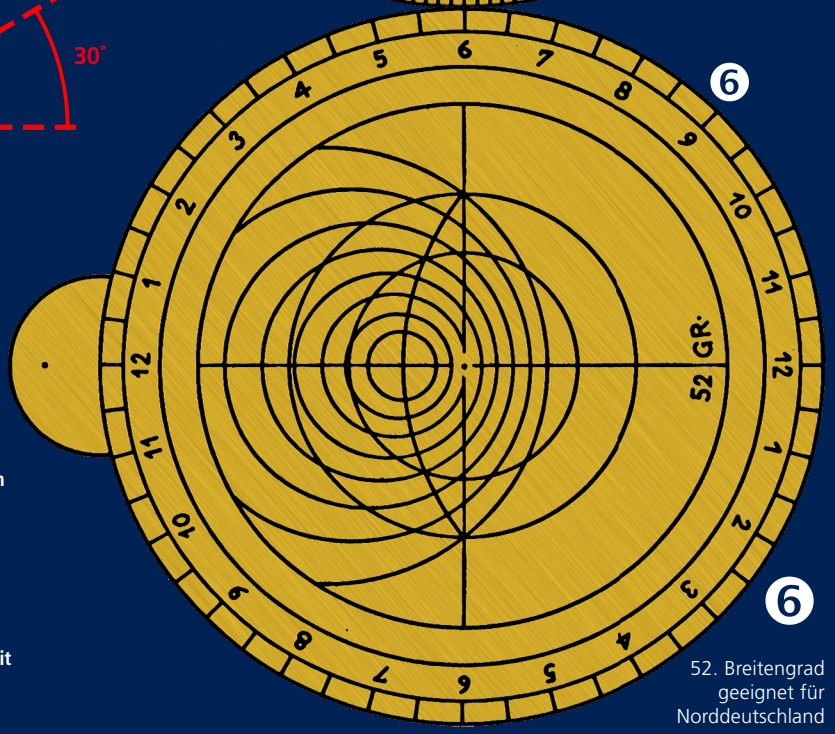
Astrolabium umdrehen und die Rete so lange drehen, bis die Zeigerspitze des gewählten Sterns auf den entsprechenden Höhenkreis zeigt. Der Abstand der Höhenkreise beträgt jeweils 10 Grad, wobei der äußerste Kreis den Horizont mit 0 Grad markiert.





Den Zeiger so drehen, dass er das aktuelle Tierkreiszeichen auf dem versetzten Tierkreis schneidet. Eine Skala auf der Rückseite erleichtert die Zuordnung von Datum und Tierkreiszeichen.

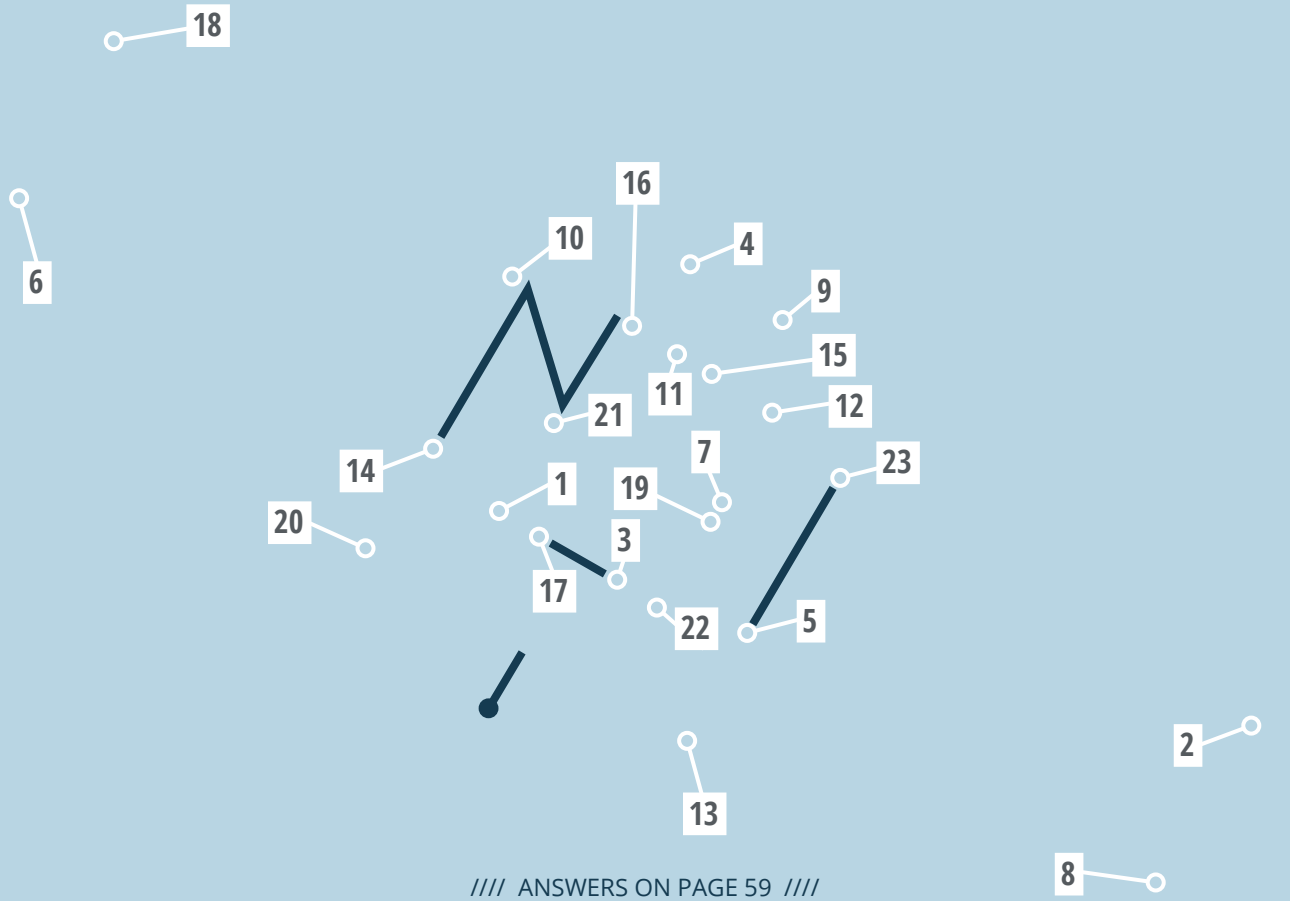
Jetzt kann auf dem Rand des Typanums die aktuelle Ortszeit abgelesen werden.



52. Breitengrad geeignet für Norddeutschland

DRAWING BOARD

First match the definitions with the words and write the corresponding number in the central column. Then join the dots in the diagram in the order of the numbers in the central column.



//// ANSWERS ON PAGE 59 ////

A small rocky object orbiting the sun.		1	cosmonaut
A combination of fuel and oxidiser.		2	hypersonic
The release of nuclear energy through the uniting of atoms.		3	fission
Outer layer of the Earth and other terrestrial planets.		4	thrust chamber
The outermost layer of the atmosphere of the sun or a star.		5	gyroscope
The Russian term for 'astronaut'.		6	fusion
A small body of matter from outer space that enters the earth's atmosphere and appears as a streak of light.		7	seismometer
A cloud of gas and dust in outer space and visible in the night sky.		8	coelostat
This rocket helps the main rocket during lift off and is jettisoned when its fuel is used up.		9	launchpad
This breaks a heavy atom into two or smaller atoms.		10	asteroid
The force that moves a rocket through the air and in space.		11	geospace
This is when a satellite passes through the line between the earth and sun or earth and moon.		12	coreolis effect
This device is used for measuring or maintaining orientation and angular velocity.		13	booster
A system of two moveable mirrors used in solar telescopes.		14	crust
This type of flight has a speed much greater than the speed of sound and is above Mach 5.		15	parachute
This is a frequency range from 27 to 40 GHz, mainly used for communication with satellites.		16	descent engine
This is a device for measuring the movement of the ground, for example on the earth or moon.		17	meteor
This makes things travelling long distance around the earth appear to move at a curve rather than a straight line due to the earth's rotation.		18	propellant
An apparatus for slowing the descent of a person or object through the air.		19	eclipse
A load-bearing base from which a rocket's flight starts.		20	nebula
The area in a propulsion rocket in which force accumulates before ejection.		21	corona
This is also called the solar-terrestrial environment.		22	thrust
This powers a spacecraft as it makes a controlled landing on the surface of a planet or moon.		23	Ka band

< PHOTO: NASA >

A TALE OF TWO

After a 50-year wait, not one but two giant rockets are being readied to take us back to the moon: NASA's Space Launch System and its competitor SpaceX Starship couldn't be more different. But space is hard and to actually land humans on the moon in the near future, the two rivals have to work together.

Moon, here we come – again. It took a few tries but by the time you read this, the first moon rocket in almost 50 years will hopefully have been *launched* from Pad 39B at NASA's Kennedy Space Center in Florida. The Space Launch System, or SLS for short, is an impressive *successor* to the legendary Saturn V moon rocket. Although at 93 metres in height a bit shorter than the Saturn V, the SLS has more *thrust* and is the most powerful rocket ever built. But probably not for long.

In a sleepy *border* village in Texas, SpaceX is working on an even bigger rocket. Starship will be the successor to the company's highly *successful* Falcon 9 rocket. Once it's operational, the 120-metre-tall, two-*stage* rocket with its 33 engines will have almost double the thrust of the SLS and top its rival in many other ways as well.

But as is often the *case* with a good rivalry, the two heavy lift rocket competitors ultimately can't do without each other – *despite* all their differences. To bring humans back to the moon they even have to work together. Here's their *tale*.

TWO HISTORIES

The Space Launch System's history dates back as far as 2005. After the loss of Space Shuttle Columbia, NASA started thinking about a *replacement* for the Space Transportation System, which is the Shuttle's official name. The idea was to reuse as many of its components to reduce costs. This was the birth of Project Constellation, which *consisted of* two rockets: Ares I was little more than a *skinny solid rocket booster*, or SRB, with a capsule on top which would carry

Nach einer Wartezeit von 50 Jahren stehen gleich zwei riesige Raketen bereit, um uns wieder zurück zum Mond zu bringen: NASAs Space Launch System und SpaceX Starship könnten unterschiedlicher nicht sein. Doch Raumfahrt ist schwierig, und um tatsächlich in naher Zukunft Menschen auf dem Mond zu landen, müssen die beiden Rivalen zusammenarbeiten.

ROCKETS

astronauts into orbit. Here they would dock with another vehicle launched by Ares V. This heavy lift rocket was basically an 'inline' variant of the Space Transport System with a *stretched* version of the Shuttle's main tank, side-*mounted* SRBs as its *core*, and its own set of engines. The second stage on top was *derived* from even older Apollo hardware.

Despite all this recycling, Constellation never got off the ground. After endless *delays* and cost overruns the program was cancelled in 2011 to be replaced soon after by the Space Launch System. SLS was *scheduled* to be operational by 2016 and to meet the aggressive deadline, the engineers again used *proven* hardware and designs: Similar to Ares V, SLS has a core stage, SRBs and four engines that are derived from the Shuttle program. The new rocket, *however*, is designed to carry both *cargo* and crew – the *latter* in a capsule initially designed >>>

booster	*Starthilfsrakete, hier auch: erste Stufe einer Rakete*
border	*Grenze*
cargo	*Fracht, Ladung*
case	*Fall*
competitor	*Konkurrent/in, Wettbewerber/in*
consist of, to	*bestehen aus, zusammengesetzt sein aus*
core	*Kern*
delay	*Verspätung*
derive, to // dɪ'raɪv	*ableiten, herrühren*
despite	*trotz, ungeachtet*
however	*jedoch, allerdings*
latter	*letztere/r/s*
launch // lɔ:ntʃ	*Start*
launch, to // lɔ:ntʃ	*starten*
mount, to	*montieren, befestigen*
proven	*bewährt, erprobt*
replacement	*Ersatz, Ablösung*
schedule, to // 'ʃedju:l	*terminieren, planen*
skinny	*dürr, dünn, mager*
solid rocket	*Feststoffrakete*
stage	*hier: Stufe*
stretch, to	*strecken, verlängern*
successful // sək'sesfl	*erfolgreich, gelungen*
successor // sək'sesə	*Nachfolger/in*
tale	*Geschichte, Erzählung*
thrust // θrʌst	*Schub*

< PHOTO: SPACEX >

< PHOTO: NASA >

The service module of the Orion spacecraft is based on the former European cargo spacecraft ATV that supplied the ISS.

for Ares I. *Yet*, all this mixing and *matching* proved to be rather complicated, which is one of many reasons SLS is now six years behind *schedule*. Maybe the NASA engineers would have been better off *starting with a blank slate*.

The *slate* SpaceX started with couldn't have been *blanker*: In 2005, when NASA first thought about what is now SLS, SpaceX hadn't put a single rocket into orbit yet. By 2016, when SLS *was supposed to* launch, Elon Musk's company had not only managed to land their first boosters but it was firmly on its way to becoming the leading global launch *provider*. But Musk, never *content* with a *success*, was thinking big and *announced* the company's next generation rocket, the ITS or Interplanetary Transport System. At the time, the idea that SpaceX could build a giant two-stage, fully reusable rocket in the *foreseeable* future seemed completely *ridiculous*. Musk, however, kept on talking about the project, which was first renamed BFR for Big F…ing Rocket and later Starship. The design, too, changed constantly – including a drastic switch from a *carbon composite* construction to *stainless* steel. It was hard to believe that this project might be anything more than a good PR *stunt* – until in 2019 the first hardware was *spotted* in a field in Texas.

There in Boca Chica near the Mexican border a water tower company began *assembling* what everyone *believed*

affectionately // ə'fekʃənətli	*liebevoll, zärtlich*
announce, to	*ankündigen, bekanntgeben*
assemble, to	*zusammenbauen, montieren*
attempt	*Versuch, Ansatz*
be supposed to, to	*sollen*
believe, to	*glauben, annehmen*
blank (blanker, blankest)	*leer, frei*
carbon composite	*Kohlefaser-Verbundwerkstoff*
catch, to (caught, caught)	*fangen, erfassen*
combustion // kəm'bʌstʃən	*Verbrennung*
cone	*Kegel*
considerably	*erheblich, wesentlich*
content // kən'tent	*zufrieden*
contraption // kən'træpʃn	*Vorrichtung, komisches Gerät*
currently	*aktuell, gegenwärtig*
deliver, to	*liefern, bringen*
develop, to	*entwickeln, ausarbeiten*
exhaust pipe // ɪg'zɔ:st paɪp	*Auspuffrohr*
expendable	*Einmal-, sich verbrauchend*
feed, to (fed, fed)	*einspeisen, füttern*
foreseeable	*absehbar*
fuel	*Brennstoff, Treibstoff*
grid fin	*Gitterflügel*
hydrogen // 'haɪdrədʒən	*Wasserstoff*
indeed	*tatsächlich, in der Tat*
insulation // ˌɪnsju'leɪʃn	*Isolierung*
interim	*vorläufig, einstweilig*
landing gear	*Landegestell*
launch escape tower // 'lɔ:ntʃ ɪ'skeɪp 'taʊə	*Rettungsrakete*
launch tower // 'lɔ:ntʃ 'taʊə	*Startturm*
likeness	*Ähnlichkeit, Gleichartigkeit*
literally	*wortwörtlich, buchstäblich*
matching // 'mætʃɪŋ	*Anpassung, Abstimmen*
oxidiser	*Oxidationsmittel*
oxygen // 'ɒksɪdʒən	*Sauerstoff*
predecessor // 'pri:dəsesə	*Vorgänger/in*
propulsion	*Antrieb, Schub, Vortrieb*
provider	*Anbieter/in, Lieferant/in*
refurbish, to // ˌri:'fɜ:bɪʃ	*überholen, wiederaufbereiten*
ridiculous // rɪ'dɪkjələs	*absurd, lächerlich*
schedule // 'ʃedju:l	*Terminplan, Zeitplan*
slate	*hier: Schreibtafel*
solution // sə'lu:ʃn	*Lösung*
spot, to	*entdecken, erblicken*
staged // steɪdʒd	*hier: stufenweise*
stainless	*rostfrei*
start with a blank slate, to	*bei Null anfangen, mit weißem Blatt Papier anfangen*
strap, to	*festschnallen*
stunt	*Trick, Gag*
success // sək'ses	*Erfolg, Gelingen*
succession // sək'seʃn	*Folge, Reihe, Nachfolge*
suggest, to // sə'dʒest	*hinweisen, suggerieren*
top off, to	*krönen, abrunden*
yet	*allerdings, dennoch*

would be, well, a water tower. In the end it turned out to be a flying engine test stand for SpaceX's new rocket engine Raptor. The *contraption*, *affectionately* called Starhopper, successfully completed a 150-metre hop. More flights – and quite a few spectacular explosions – followed in quick *succession*, first of various full-sized tanks and then of early prototypes of Starship's upper stage. At the same time SpaceX was turning that Texan field into a giant rocket factory and building a *launch tower* nearby at breathtaking speed. Today, the upper-stage Starship has flown to a height of 12 kilometres and landed successfully. A booster, called Super Heavy, and Starship number 24 are *currently* going through a series of tests and static fires before their first orbital *attempt* by the end of the year.

TWO DESIGNS

Just as different as the history of these two heavy lift rockets is their design. SLS looks a bit like a Saturn V moon rocket with Space Shuttle SRBs *strapped* to its side. Like the Shuttle, its first stage uses liquid *hydrogen* as *fuel* and liquid *oxygen* as *oxidiser*. Although the 64-meter-tall core stage with its characteristic orange *insulation* looks a bit like a stretched copy of the Shuttle's main tank, it is *indeed* a completely new design. After all, it has to transfer all 39 Meganewtons of thrust from the engines and SRBs to the rest of the rocket. The main engines are four RS-25 engines from the Space Shuttle – *literally* from the Space Shuttle. All four engines of the current Artemis I mission are *refurbished* Shuttle engines and have flown several times before. The upper stage, or *Interim* Cryogenic *Propulsion* Stage, is a modified second stage from the Delta rocket family and, as the name *suggests*, an interim *solution* until a more powerful stage becomes available. On top of all this sits the Orion spacecraft.

It's hard not to compare Orion to its famous *predecessor*. While it has the same iconic *cone* shape as the Apollo capsule, Orion's crew module is almost twice as roomy and can carry four astronauts to the moon and six to the ISS. The European-built service module is derived from ESA's Automated Transfer Vehicle, which *delivered* cargo to the ISS on five missions. Finally, to make the Apollo *likeness* complete, a *launch escape tower tops off* the whole rocket.

Like the original moon rocket, the Space Launch System is designed as an *expendable* rocket. Except for the small crew capsule all of its parts will end up either at the bottom of the ocean or somewhere in space. With such a design philosophy, all the used parts and moon-shot references, SLS is, despite its glory, space business as usual. Which can't be said of Starship.

Probably the biggest difference between the two systems is that Starship is designed from the ground up as a completely reusable rocket, something which has never been done before. Not only will the booster return but also the upper stage. Called Super Heavy, the booster is a 70-meter-tall, 9-meter-wide, stainless-steel cylinder. It holds 3,400 tons of liquid methane and liquid oxygen which are *fed* into 33 Raptor 2 engines. *Developed* by SpaceX, the Raptor 2 is a completely new design based on the full-flow *staged-combustion*-cycle principle. While most rocket engines have an '*exhaust pipe*' or waste some fuel to power their turbo pumps, the Raptor turns all of its fuel into thrust – a lot of thrust! Combined, Starship's 33 engines produce 72 Meganewtons of thrust – *considerably* more than SLS and about twice as much as the Saturn V moon rocket.

Like its little sister the Falcon 9, the Super Heavy has four *grid fins* to steer it on the way back but no *landing gear* of any sort. Instead, the rocket will be *caught* by the >>>

GRAMMAR BIT

WHICH

... see highlighted examples in text.

The word **'which'** in a sentence can either **'define'** what comes before it or simply **add extra information**. When writing, the comma is important in this case as it can change the meaning of what is written, e.g.

- The panel which controls the blinds operates the lighting. (but the panel which controls the AC doesn't operate the lighting, i.e. there are several panels)
- The panel, which also controls the blinds, operates the lighting. (there is only one panel)

/// EXERCISE ON PAGE 52 ///

< PHOTO: SPACEX >

Both reusable stages of the Starship have wings: The booster (foreground) is equipped with Falcon-9-like grid fins and the upper stage has wings to control its descent, similar to a sky diver.

< PHOTOS: SPACEX >

Launch, flip, crash, repeat: SpaceX isn't afraid to break things. It took the engineers a few Starships before they managed its spectacular flip manoeuvre and the landing.

launch tower, which for this *purpose* is *equipped* with two giant arms. These so-called *chopsticks* can travel up and down and close around the *hovering* booster during landing. Sounds crazy? Definitely, but landing a booster on a *rocking barge* in the middle of the ocean sounded equally crazy when it was first announced. Today, SpaceX lands their booster *dead centre* on a weekly basis. It may take some time – and probably a few more spectacular explosions – to *grab* a 200-ton booster from mid-air but the SpaceX engineers will figure it out eventually.

On top of the booster sits the Starship upper stage, which adds another 50 meters to the *stack* to make it the largest rocket ever built. Even at first *glance* it is *obvious* that Starship is a *unique* spacecraft: It has two sets of *wings*. These are used for *steering* the ship when it returns *belly* first from space and help *flip* it into an upright position in a spectacular manoeuvre shortly before landing. The first prototypes had *stubby* landing legs but eventually Spaceship, too, will be caught out of the air with the chopsticks.

With its six Raptor 2 engines, Starship is capable of delivering *payload* with a volume of over 1,000 cubic meters and more than 100 tons of mass into low earth orbit – both numbers are unheard of and way beyond SLS's or the *venerable* Saturn V's *capabilities*.

TWO MISSIONS

With Starship's impressive specifications and *reusability* the single-use Space Launch System seems somewhat outdated and *superfluous*, especially considering the eye-watering price *tag* of one *billion* US Dollars per launch. Then again, the two mega rockets have completely different mission profiles.

SLS was designed as a *human-rated* launch system to take humans beyond Earth's orbit. Its Orion crew module is currently the only spacecraft in the world capable of supporting a crew for weeks at a time while protecting them from the high *radiation* in deep space and the extreme heat during the much faster re-entry back from the moon. It therefore has to be much *sturdier*, and heavier, than SpaceX's *sleek* Crew Dragon capsule and all the other space ships which regularly *ferry* astronauts to the ISS. SLS' current *uncrewed* Artemis I mission is a *dry run* to test out Orion's *durability*. Probably in 2024, a crew of four will then fly a *loop* around the moon with Artemis II before "the first woman and the next man" will return to the *surface* of the moon on Artemis III no earlier than 2025.

Starship, too, may one day carry astronauts into space – thanks to its capacity probably even dozens at a time – but certainly not any time soon. Even when the system is operational and Starships and Super Heavies return into the open arms of the launch tower on a regular basis, NASA will be *reluctant* to put their astronauts on board. Since Starship *lacks* any kind of launch escape system there's no way to separate the crew from the rest of the rocket, which during a launch *failure* might suddenly turn into a giant bomb.

Instead, Starship will *initially* carry lots and lots of cargo into orbit – first and foremost the next, much larger version of SpaceX's Starlink communication satellite. Even the Starship prototype that's *slated* for its *maiden flight* into orbit later this year is already equipped with a satellite *dispenser* and a small cargo door.

But Starship doesn't have 'star' in its name for nothing. Like SLS it's designed to leave earth's orbit and *venture* to the stars – after a *brief pit stop*, that is. To transport its massive payloads even further, say the Moon, Mars or the planets, Starship can be refilled in orbit. Thanks to the reusability of the entire rocket, it becomes economically *feasible* to launch several tankers that slowly fill up an orbiting 'gas station'. Once that has been *topped up*, an *outbound* Starship simply docks and fills up before heading "to *infinity* and beyond". Again, this has never been tried before but at the rate SpaceX is build-

barge // bɑːdʒ	*Schleppkahn, Barge*
belly	*Bauch*
billion	*Milliarde*
brief	*kurz, knapp*
capability	*Fähigkeit*
chopstick	*Essstäbchen*
dead centre	*genaue Mitte*
dispenser	*Spender, Ausgeber*
do away with, to (did, done)	*abschaffen, sich entledigen*
dry run	*Probelauf, Testlauf*
durability // ˌdjʊərə'bɪləti	*Widerstandsfähigkeit*
equip, to	*ausrüsten, ausstatten*
failure // 'feɪljə	*Versagen, Fehler, Ausfall*
feasible	*machbar, praktikabel*
ferry, to	*befördern, transportieren*
flip, to	*umdrehen, wenden*
gently	*sanft, behutsam*
glance	*Blick*
grab, to	*greifen, schnappen*
hover, to // 'hɒvə	*schweben*
human-rated	*für Passagiere ausgelegt*
infinity	*Unendlichkeit*
initially // ɪ'nɪʃəli	*ursprünglich, anfänglich*
lack, to	*ermangeln, nicht haben*
launch pad // 'lɔːntʃ pæd	*Startrampe, Startplattform*
loop	*Schleife, Schlaufe*
maiden flight	*Jungfernflug, Erstflug*
merely // 'mɪəli	*nur, lediglich, bloß*
obvious // 'ɒbvɪəs	*offensichtlich, augenscheinlich*
order of magnitude	*Größenordnung*
outbound	*abfliegend, abgehend*
outsize, to	*an Größe übertreffen*
payload	*Nutzlast*
pit stop	*Boxenstopp*
provide, to	*bieten, liefern*
purpose // 'pɜːpəs	*Zweck, Absicht*
radiation	*Strahlung*
reluctant	*zurückhaltend, zögerlich*
reusability	*Wiederverwendbarkeit*
rock, to	*schaukeln, schwanken*
slate, to // sleɪt	*ansetzen*
sleek	*elegant, schnittig*
spindly	*spindeldürr, staksig*
stack	*Stapel*
steer, to	*steuern, lenken*
stubby	*stummelig, kurz und dick*
sturdy (sturdier, sturdiest)	*robust, stabil widerstandsfähig*
submission	*Einreichung, Einsendung*
superfluous // suː'pɜːfluəs	*überflüssig, entbehrlich*
surface // 'sɜːfɪs	*Oberfläche*
surprise	*Überraschung, Verblüffung*
tag // tæg	*Schild, Etikett*
thruster	*Schubdüse*
top up, to	*auffüllen, nachfüllen*
uncrewed	*unpilotiert, unbemannt*
unique // juˈniːk	*einzigartig, einmalig*
unlikely	*ungleich, verschieden*
venerable // 'venərəbl	*altehrwürdig, ehrenwert*
venture, to // 'ventʃə	*sich hinauswagen*
wing	*Flügel, Tragfläche*

ing Starships in Boca Chica there's at least enough hardware to try it until it works. And it had better work.

ONE GOAL

Provided everything goes to plan, SLS and Starship, the two rivals on the *launch pad*, will work together in the not-so-distant future. While SLS is perfectly capable of delivering astronauts to an orbit around the moon it can't bring along a lander thanks to the 'interim' status of its second stage. To save costs, and probably some time, NASA therefore asked private companies to build a lander and deliver it into a lunar orbit for them. In a *surprise* move, NASA chose a modified Starship over the two other more classic and *spindly submissions*. The Starship Human Landing System, or HLS for short, *does away with* wings and heatshield as it won't be returning to the Earth. Instead, it will be equipped with landing legs and extra *thrusters* to touch down *gently* on the moon's surface.

When Orion and Starship HLS finally dock in lunar orbit they will be quite an *unlikely* couple. The lander will *outsize* the crew vehicle by an *order of magnitude*. One *merely* >>>

The moon program has literally grown: While Orion has about three times the volume of the Apollo capsule, the SpaceX lander outsizes the 1960s lunar module by an order of magnitude.

< PHOTOS: NASA >

carries four people while the other delivers some 50-plus tons and two astronauts to the lunar surface. As with any unlikely couple this may seem *odd* at first but there's a reason the two are *sticking* together. NASA's SLS and SpaceX's Starship can't do it on their own; they need each other to, as Kennedy famously put it, "*achieve* the *goal* of landing a man on the Moon and returning him safely to Earth." Only this time there will be many more … and women, too. *<<< Matthias Meier >>>*

achieve, to // ə'tʃi:v	*erreichen, erzielen*
goal // gəʊl	*Ziel*
odd	*seltsam, komisch*
stick, to	*kleben, hängen bleiben*

Links, Vokabeln & mehr unter
www.inchbyinch.de/inch34/moonrocket

www.nasa.gov/specials/artemis
www.nasa.gov/exploration/systems
www.nasa.gov/exploration/systems/orion
Offizielle NASA Webseiten zur aktuellen Artemis I Mission, dem Space Launch System und der Orion Raumkapsel.

www.spacex.com/vehicles/starship
Homepage von SpaceXs Starship mit weiteren Informationen zur komplett wiederverwendbaren Megarakete.

https://everydayastronaut.com/sls-vs-starship
https://everydayastronaut.com/raptor-engine
Sehr ausführlicher Vergleich von SLS und Starship sowie eine exzellente Erklärung des Raptor Raketentriebwerks mit zugehörigen Videos des Raumfahrt-Vloggers Tim Dodd.

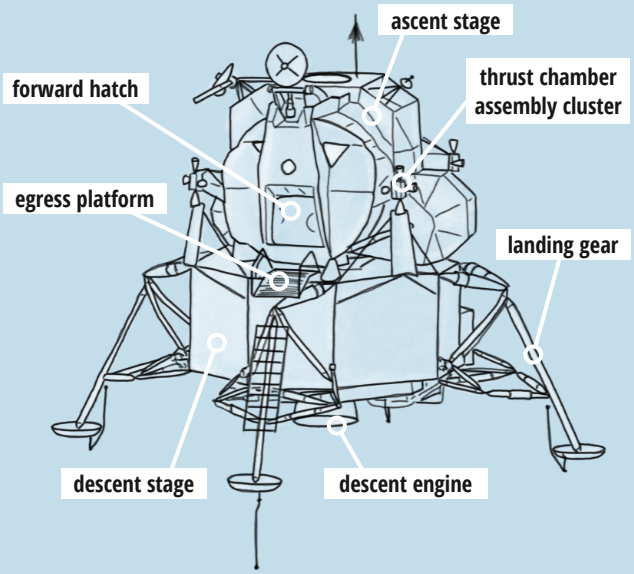
https://arstechnica.com/science/2022/08/the-sls-rocket-is-the-worst-thing-to-happen-to-nasa-but-maybe-also-the-best
Artikel von Raumfahrtjournalist Eric Berger, der die Sinnhaftigkeit des SLS Programms hinterfragt.

www.scientificamerican.com/article/spacexs-starship-and-nasas-sls-could-supercharge-space-science
Der Scientific American Artikel beschreibt den Einfluss, den SLS und Starship außerhalb des Mondprogramms auf die Erkundung des Sonnensystems haben können.

www.youtube.com/watch?v=mhJRzQsLZGg
Nur einer von über einem Dutzend rund um die Uhr Live-Feeds, mit denen man das Geschehen auf der Starship Baustelle verfolgen kann.

TECH EXTRAS

PICTORIAL **LUNAR MODULE**



available	*verfügbar, vorhanden*
combustion chamber // kəm'bʌstʃən tʃeɪmbə	*Brennkammer*
depend on, to	*abhängen von*
eject, to	*auswerfen*
fuel	*Brennstoff, Treibstoff*
ignite, to	*entzünden*

HOW **ROCKET ENGINES** WORK

Rocket engines are reaction engines which produce *thrust* by *ejecting* mass – the more and the faster the better. *Liquid propellant* rocket engines do so by *injecting fuel* and an *oxidiser* into a *combustion chamber* and *igniting* it. The burning fuel then exits through the *nozzle*. An oxidiser is needed because most rockets operate in the vacuum of space where no atmospheric *oxygen* is *available*.

Fuel and oxidiser are fed into the combustion chamber via pumps, which might be electric but are usually turbopumps. A small part of the fuel and oxidiser is burned in a preburner, basically a small rocket engine, to power a turbine which in turn drives the pumps. *Depending on* the fuel used, these preburners, turbines and pumps can be arranged differently to optimise engine efficiency and thrust.

inject, to	*einspritzen*
liquid	*flüssig*
nozzle // 'nɒzl	*Düse*
oxidiser	*Oxidationsmittel*
oxygen // 'ɒksɪdʒən	*Sauerstoff*
propellant	*Treibstoff, Kraftstoff*
thrust // θrʌst	*Schub*

ROCKET SLING

Es ist ein bisschen wie David gegen Goliath: Statt mit teuren Raketen will Spinlaunch bald Satelliten einfach mit einer riesigen Hightech Schleuder ins Weltall katapultieren. Ein erster, erfolgreicher Test beweist, dass dies mehr als eine verrückte Idee ist.

< PHOTO: SPINLAUNCH >

It's literally David *versus* Goliath in space. Goliath being the space industry which for decades has *relied on combustion* and massive *boosters* to "throw" rockets into space. Spinlaunch, a 21st century David, however, wants to use a *sling* to *fling* satellites into orbit. Their idea is pretty simple: Attach a *payload* to a *tether*, *spin* it up – preferably in a vacuum to *avoid* aerodynamic *drag* – until it reaches a high enough *circumferential* speed, and release.

Until recently, most experts might have *dismissed* the whole idea – except maybe as an entertaining thought experiment for an *undergraduates*' lesson on centripetal forces. At the end of October, however, Spinlaunch proved that their concept is anything but a "wild shot" by successfully slinging their first projectile from a *small-scale* demonstrator.

Maybe 'small' isn't the right word for a 50-meter-tall steel structure. Spinlaunch's sub-orbital *accelerator* is basically a giant vacuum *chamber* – one of the largest in the world – in which a carbon fibre tether with a 3-meter-long projectile on one end and a *counterweight* on the other rotates. During the first test the accelerator was spun up to 450 rpm – about 20 percent of its capacity. Released with microsecond precision, the projectile then travelled through the exit *chute* and *ripped* the membrane sealing the vacuum before it, quite literally, hit the atmosphere at a speed of Mach 1 – enough to send it to an *apogee* of some 3,000 meters.

This might be little more than a proof-of-concept but the company is already working on an orbital accelerator 100 meters in diameter capable of catapulting a small rocket with a 200-kilogram payload half way into orbit. Spinlaunch's aim is to replace the heavy and expensive first stage of today's *launchers* with a ground-based, purely electromechanical system which would reduce costs and risks.

Throwing instead of pushing things into orbit isn't a new concept. In the 1960s the High *Altitude* Research Project successfully used a very large gun to fire projectiles to an altitude of 179 kilometres. Others have *suggested* the use of electric *railguns* or slings similar to Spinlaunch's. All these concepts have to overcome two major *hurdles*.

The first is the transition from the vacuum to atmosphere – basically a *reverse* and instant version of an atmospheric *re-entry* during which the projectile heats up to white-hot temperatures within seconds.

The other is the enormous g-load on the projectile. During spin-up, Spinlaunch's orbital accelerator will reach up to 10,000 g. While electronics, even an *off-the-shelf* smartphone, can take these kinds of loads with ease, other components such as rocket motors, *reaction wheels* or solar panels have to be redesigned, something Spinlaunch is currently working on.

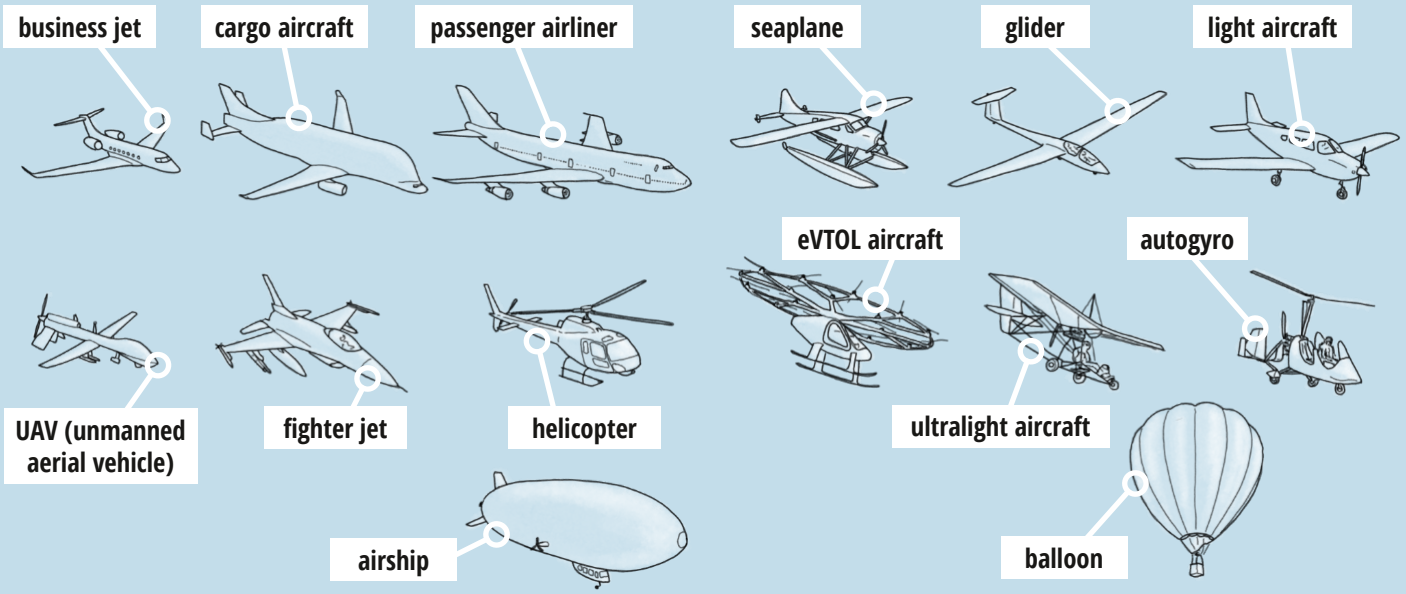
Space David's sling may not *topple* the space industry Goliath yet, but in certain payload markets it could certainly leave a *dent*. *<<< Matthias Meier >>>*

www.spinlaunch.com
Webseite von Spinlaunch mit Video des ersten Tests und weiteren Infos.

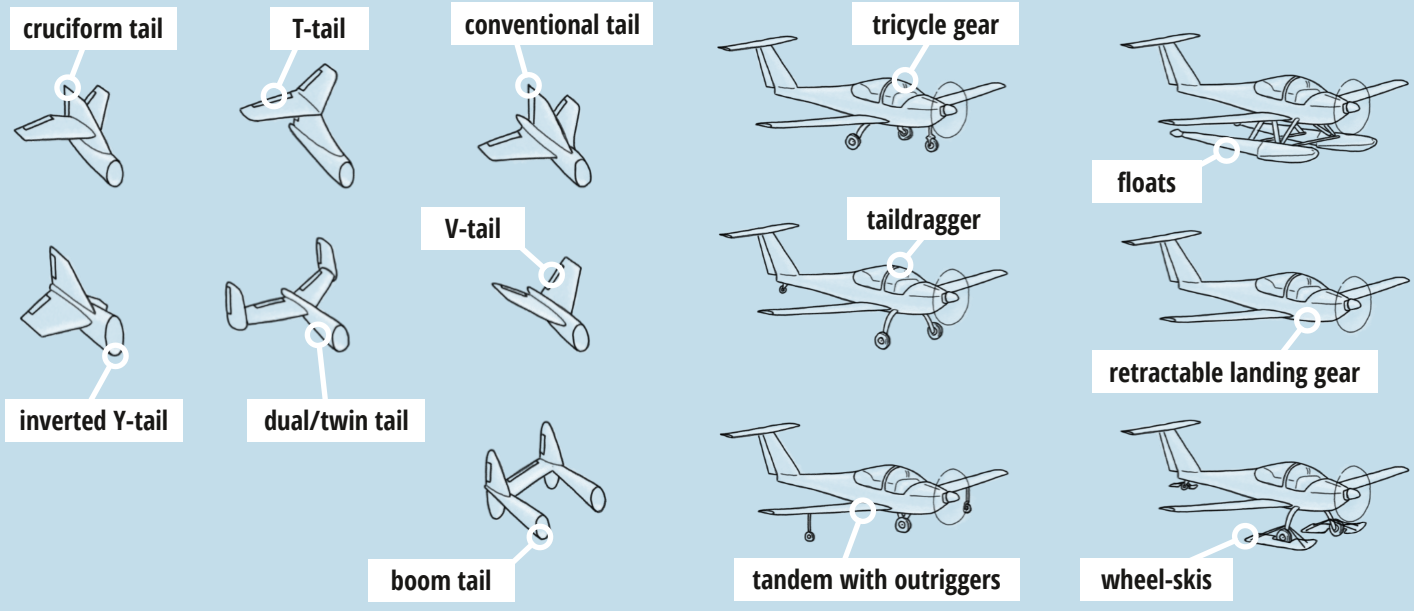
https://youtu.be/JAczd3mt3X0
Gute Videoanalyse von Raumfahrt-Vlogger Scott Manley.

accelerator // ək'seləreɪtə	*Beschleuniger*
altitude	*Höhe, Flughöhe*
apogee // 'æpədʒi:	*Scheitelpunkt*
avoid, to	*vermeiden, umgehen*
booster	*Trägerrakete, auch: 1. Raketenstufe*
chamber // 'tʃeɪmbə	*Kammer*
chute // ʃu:t	*hier: Schacht*
circumferential // ˌsəkʌmfər'renʃl	*Umfangs-*
combustion // kəm'bʌstʃən	*Verbrennung*
counterweight	*Gegengewicht*
dent	*Delle, Eindruck, Beule*
dismiss, to	*abtun, verwerfen*
drag // dræg	*(Strömungs-) Widerstand*
fling, to	*schleudern, werfen*
hurdle // 'hɜ:dl	*Hindernis, Hürde*
launcher // 'lɔ:ntʃə	*hier: Trägerrakete*
off-the-shelf	*von der Stange, handelsüblich*
payload	*Nutzlast*
railgun	*Schlittenkanone*
re-entry	*Wiedereintritt*
reaction wheel	*Reaktionsrad, Drallrad*
rely on, to	*sich verlassen auf, bauen auf*
reverse	*umgekehrt, entgegengesetzt*
rip, to	*aufreißen, auftrennen*
sling	*hier: Schleuder*
small-scale	*kleinmaßstäblich*
spin, to	*drehen, wirbeln*
suggest, to // sə'dʒest	*vorschlagen, anregen*
tether // 'teðə	*Halteseil*
topple, to	*umstürzen, ins Wanken bringen*
undergraduate	*Student/in ohne Abschluss*
versus // 'vɜ:səs	*gegen*

AERONAUTICS

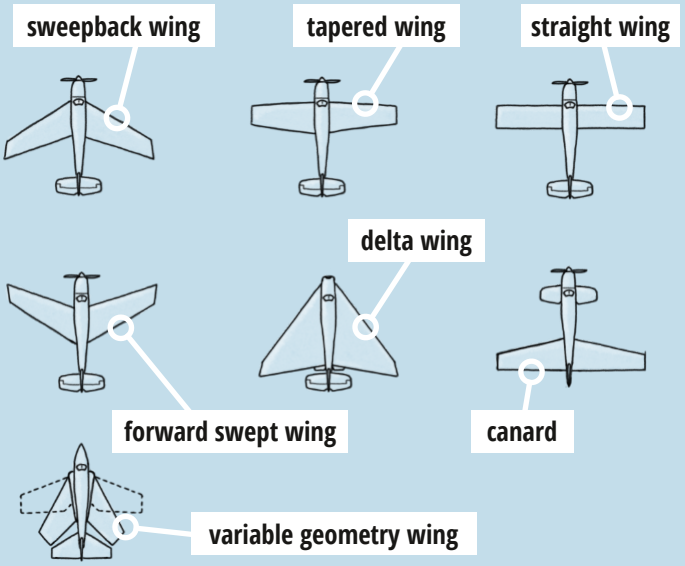


AIRCRAFT TYPES

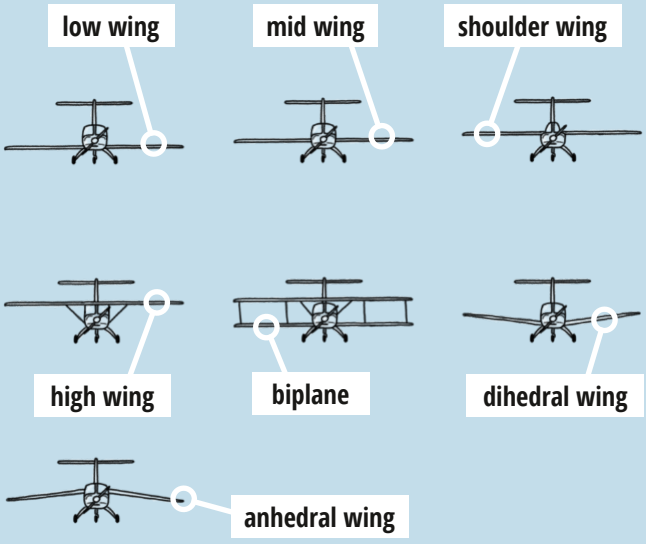


AEROPLANE TAIL/EMPENNAGE TYPES

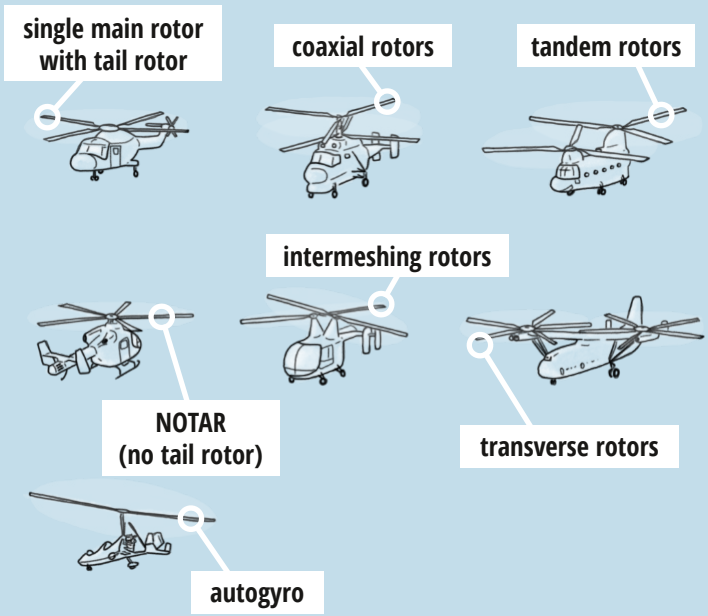
LANDING GEAR TYPES



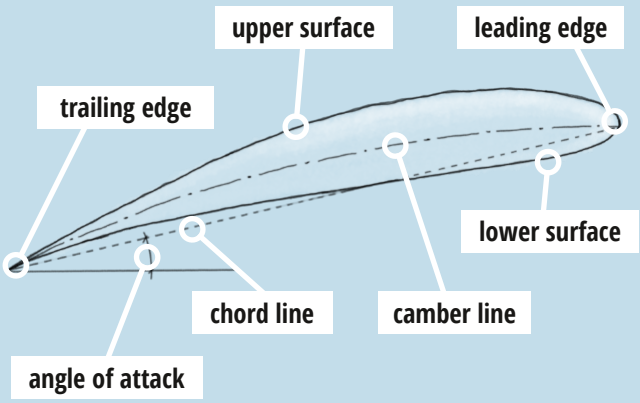
PLANFORMS (WING SHAPES)



WING POSITIONS



ROTOR CONFIGURATIONS (HELICOPTER)



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SPACE TECHNOLOGY

ablation	*Abbrand*
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apoapsis	*Apoapsis*
apogee	*Apogäum*
artificial gravity	*künstliche Schwerkraft*
ascent	*Aufstieg*
astronaut	*Raumfahrer/in*
attitude	*Fluglage*
azimuth	*Azimut*
ballistics	*Ballistik*
barycentre	*Massenmittelpunkt*
bi-propellant	*Diergol*
boilerplate	*Rohmodell*
booster	*Starthilfsrakete*
bow shock	*Bugstoßwelle*
burn, to	*brennen*
celestial sphere	*Himmelssphäre*
cislunar	*zwischen Mond und Erde*
combustion	*Verbrennung*
combustion chamber	*Brennkammer*
command module	*Kommandokapsel*
constellation	*Sternbild*
coolant	*Kühlflüssigkeit*
cryogenic	*kryogenisch*
decay	*Abfall*
deceleration	*Verzögerung*
declination	*Deklination*
decompression	*Druckabnahme*
descent	*Abstieg*
descent module	*Landekapsel*
dish antenna	*Parabolantenne*
downlink	*Abwärtsstrecke*
drag	*Luftwiderstand*
ejection seat	*Schleudersitz*
elevation	*Höhe*
engine	*Triebwerk*
engine bell	*Triebwerksglocke*
escape tower	*Rettungsturm*
escape velocity	*Fluchtgeschwindigkeit*
extravehicular activity	*Außenbordeinsatz*
fairing	*Verkleidung*
flyby	*Vorbeiflug*
free-fall	*freier Fall*
g-force	*g-Kraft*
geostationary orbit	*geostationäre Umlaufbahn*
geosynchronous orbit	*geosynchrone Umlaufbahn*
gimbal	*kardanische Aufhängung*
gravity	*Schwerkraft*
gravity assist	*Gravitationsschwung*
grid fin	*Gitterflügel*
gyroscope	*Kreiselgerät*
hatch	*Luke*
heat shield	*Hitzeschild*
heliocentric	*heliozentrisch*
helmet	*Helm*
high-gain antenna	*Hochleistungsantenne*
Hohmann transfer orbit	*Hohmann Transfer-Umlaufbahn*
hydrogen	*Wasserstoff*
hyperbolic	*hyperbolisch*
hypergolic	*hypergolisch*
inclination	*Neigung*
injector	*Einspritzdüse*
integrated circuit	*integrierte Schaltung*
ion engine	*Ionentriebwerk*
kinetic energy	*kinetische Energie*
Lagrange point	*Lagrangepunkt*
landing	*Landung*
landing leg	*Landebein*
latitude	*Breitengrad*
launch	*Start*
launch pad	*Startplatz*
launch table	*Starttisch*
launch tower	*Startturm*
launch vehicle	*Trägerrakete*
launch widow	*Startfenster*
liftoff	*Abheben*
light speed	*Lichtgeschwindigkeit*
liquid	*flüssig*
longitude	*Längengrad*
longitudinal axis	*Längsachse*
low earth orbit	*niedere Erdumlaufbahn*
low-gain antenna	*Niederleistungsantennen*
lunar	*Mond-*
lunar roving vehicle	*Mondauto*
mass fraction	*Massenanteil*
mass ratio	*Massenverhältnis*
mean solar time	*mittlere Sonnenzeit*
meridian	*Längenkreis*
microgravity	*Mikroschwerkraft*
missile	*Geschoss*
mock-up	*Attrappe*
module	*Modul*
momentum	*Moment*
multi-stage rocket	*Mehrstufenrakete*
nadir	*Tiefpunkt*
nitric acid	*Salpetersäure*
nitrogen tetroxide	*Stickstofftetroxid*
nozzle	*Düse*
occultation	*Verfinsterung*
omnidirectional	*ungerichtet*
orbit	*Umlaufbahn*
orbit insertion	*Einbringung in die Umlaufbahn*
orbit trim manoeuvre	*Bahnkorrekturmanöver*
orbital	*orbital*
orbital mechanics	*Bahnmechanik*
orbital velocity	*Orbitalgeschwindigkeit*
orbiter	*Orbiter*

apogee, booster, cislunar, descent module, escape tower, flyby, gravity assist, hatch, inclination, kinetic energy, launch window, multi-stage rocket, nozzle, orbiter, pressure suit, re-entry, space station, thruster, ullage, velocity, weightlessness, X-axis, yaw, zenith – ***200+ space technology terms***

oxidizer	*Oxidationsmittel*
oxygen	*Sauerstoff*
parachute	*Fallschirm*
parking orbit	*Parkumlaufbahn*
payload	*Nutzlast*
periapsis	*Periapsis*
perigee	*Erdnähe*
perihelion	*Sonnennähe*
pitch	*Nicken*
plasma engine	*Plasmatriebwerk*
polar orbit	*polare Umlaufbahn*
potential energy	*Lageenergie*
precession	*Kreiselbewegung*
pressure suit	*Druckanzug*
pressurized	*druckbaufschlagt*
probe	*Sonde*
prograde	*rechtläufig*
propellant	*Treibmittel*
propulsion	*Treibkraft*
pyrotechnics	*Pyrotechnik*
radiation	*Strahlung*
radio astronomy	*Radioastronomie*
radioisotope thermoelectric generator	*Radioisotopengenerator*
re-entry	*Wiedereintritt*
re-entry vehicle	*Wiedereintrittskörper*
reaction control system	*Lageregelungssystem*
reaction wheel	*Reaktionsrad*
receiver	*Empfänger*
redundancy	*Redundanz*
refraction	*Brechung*
regenerative cooling	*Regenerativkühlung*
remote sensing	*Fernerkundung*
rendezvous	*Rendezvous*
retrograde	*rückläufig*
reusable	*wiederverwendbar*
revolution	*Umlauf*
rocket	*Rakete*
roll	*Rollen*
rotation	*Umdrehung*
satellite	*Satellit*
satellite bus	*Satellitenplattform*
service module	*Service-Modul*
solar array	*Solaranlage*
solar cell	*Solarzelle*
solar panel	*Sonnenkollektor*
solid propellant	*Festtreibstoff*
solid rocket	*Feststoffrakete*
sounding rocket	*Höhenforschungsrakete*
space	*Weltraum*
space debris	*Weltraumschrott*
space station	*Raumstation*
space technology	*Raumfahrttechnik*
space weather	*Weltraumwetter*
spacecraft	*Raumschiff*
specific impulse	*spezifischer Impuls*
spin stabilisation	*Drallstabilisierung*
stage	*Stufe*
star	*Stern*
static firing	*statische Zündung*
stratosphere	*Stratosphäre*
sub-orbital	*suborbital*
sun synchronous orbit	*sonnensynchrone Umlaufbahn*
synthetic aperture radar	*Radar mit synthetischer Apertur*
telemetry	*Fernmesstechnik*
terrestrial	*Erd-*
thermal energy	*Wärmenergie*
thermal tile	*Hitzeschildkachel*
throat	*Einschnürung*
throttle	*Drossel*
thrust	*Schub*
thrust chamber	*Verbrennungskammer*
thrust vector control	*Schubvektorsteuerung*
thruster	*Schubdüse*
tracking station	*Beobachtungsstation*
trajectory	*Flugbahn*
trajectory corrective manoeuvre	*Bahnkorrekturmanöver*
trans-lunar injection	*Trans Lunar Injection*
transmitter	*Funksender*
transponder	*Antwortsender*
turbopump	*Turbopumpe*
two-way	*wechselseitig*
ullage	*Tankleerraum*
umbilical	*Nabelschnur*
uplink	*Aufwärtsstrecke*
velocity	*Geschwindigkeitsvektor*
velocity vector	*Geschwindigkeitsvektor*
wavelength	*Wellenlenge*
weightlessness	*Schwerelosigkeit*
X-axis	*X-Achse*
X-ray	*Röntgenstrahl*
Y-axis	*Y-Achse*
yaw	*Gieren*
Z-axis	*Z-Achse*
zenith	*Scheitelpunkt*
zero gravity	*Schwerelosigkeit*

Vokabeltrainer und Download unter
www.inchbyinch.de/dictionary/spacetech

METROLOGY

We measure constantly. When we lift a pen, our senses measure its weight, and when we walk, our body registers *acceleration*, speed and the distance to our *destination*. In engineering we *conduct* tests to optimise our designs or check parameters to verify the quality of our products. But what exactly is a measurement?

When measuring we *quantify* a certain *property* of something, e.g. a body, a substance or a physical phenomenon, by comparing it to a given standard *unit*. The result of the measurement therefore comes in two parts – a unit of measurement according to the property and a number for how many times the standard unit is *contained* in the measured object. Two of many properties of a steel *girder* are its mass and length. According to the Système International d'Unites, or SI units, the unit of the property mass is kilogram (kg) and the unit of the length is metre (m). Compared to the prototype of the kilogram and metre kept in Paris (or their *contemporary* definitions), the girder might be five times a standard metre and 500 times a standard kilogram.

If the measurement is taken by comparing the length of the girder to something with the same property, i.e. the length of a *ruler*, it's called a direct measurement. An indirect measurement, in contrast, looks at a different property, maybe the time sound takes to travel from one end of the girder to the other.

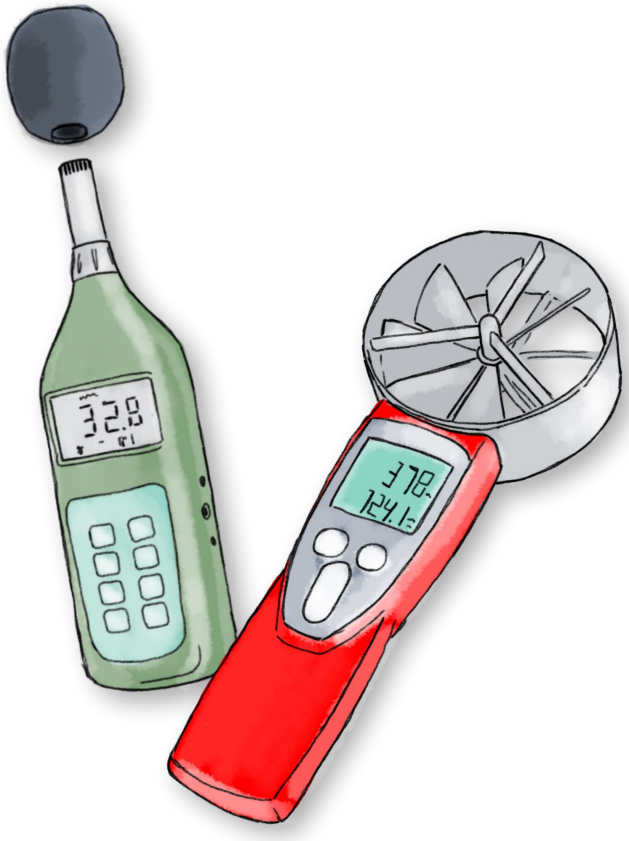
EVERY MEASUREMENT IS INEXACT

No matter how *elaborate* a test setting might be, or how carefully we take a measurement, there's always a *margin* of doubt. *Inaccuracy* is an integral part of any measurement. Since a measurement is *faulty* by definition, several measurement *attempts* will return different results. The difference between the measured *value* and the true value is called an error. There are many sources of errors.

Most importantly, all *environmental* effects should be *taken into consideration*. Temperature influences the length or volume of an object; other local conditions like air pressure, *elevation* or *humidity* might affect other properties. The measured item should also be stable. A *shifting* frequency or a leaking container are hard to measure. Naturally, the measuring instrument also plays an important

CONVERSION TABLE

LENGTH	
1 inch	2.54 centimetres
0.394 inches	1 centimetre
1 foot = 12 inches	0.305 metres
1 yard = 3 feet	0.914 metres
1.094 yards	1 metre
1 mile = 1760 yards	1.609 kilometres
0.621 miles	1 kilometre
VOLUME IMPERIAL	
1 fluid ounce (fl oz)	28.413 millilitres
1 pint (pt) = 20 fl oz	0.568 litres
1 gallon = 8 pints	4.546 litres
VOLUME US	
1 fluid ounce (fl oz)	29.574 millilitres
1 pint (pt) = 16 fl oz	0.473 litres
1 gallon = 8 pts	3.785 litres
MASS	
1 ounce (oz)	28.35 grams
0.035 ounces	1 gram
1 pound (lb) = 16 oz	0.454 kilograms
2.205 pounds	1 kilogram
1 stone = 14 lb	6.35 kilograms



Wer misst, misst Mist – so lautet eine alte Ingenieursweisheit. Und dennoch kommen wir bei unserer täglichen Arbeit ums Messen nicht herum. Unsere Basics zeigen, worum's beim Messen geht und wie wir möglichst genau messen können.

role and any faults can easily be multiplied. Electric noise interfering with sensors or a worn out *vernier calliper* are just two of many examples. Equally important as the measuring instrument is the operator and the process they set up. Reaction times in using a stopwatch vary from person to person and measuring the *circumference* of a cylinder with a *folding rule* is definitely poor practice.

RANDOM OR SYSTEMATIC

All these errors mentioned above can be either random, systematic or, in the worst case, both. A systematic error is one which *occurs* with the same value for each of the repeated measurements. The *jaws* of a vernier calliper might be bent resulting in an extra millimetre for each measured length. Or an operator always takes the same tenth of a second reaction time before pressing a button. Because they are constant and happen all the time, systematic errors are very hard to tell. To reduce the risk of systematic effects, measuring instruments regularly have to be checked, i.e. tested against a standard of higher *accuracy*. Such a calibration might be done by comparing the *equipment* to that of a calibration laboratory, which in turn is tested against national standards to *ensure* the *traceability* of the measurement.

Other strategies to avoid systematic errors include using different measuring methods or different set-ups. Naturally, *skilled* operators and a *sophisticated* process are equally important.

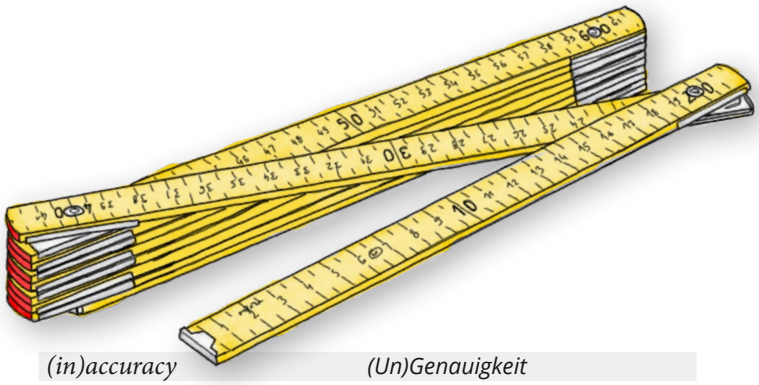
Random errors, in contrast, are *unavoidable* but can be *detected* and quantified by repeating the measurement.

MEASURE *THRICE*, CUT ONCE

Since, by definition, each measurement is different, a series of tests will result in a *spread* of values representing a *probability distribution*. This distribution can be used to quantify the doubt about the measurement result or the *uncertainty*. A measurement result is only complete when accompanied by a statement of its uncertainty. The *degree* of uncertainty might be important in deciding whether or not a result is adequate for a certain *purpose*. It also allows us to compare results and see if they are *consistent*.

In most cases, the distribution of the values will be a normal or Gaussian distribution with its characteristic bell shape. Statistical methods are then used to calculate the standard deviation. A standard uncertainty is defined as the margin whose size can be thought of as 'plus or minus one standard deviation'. By converting them to the standard uncertainty, all *contributing* uncertainties are expressed at the same *confidence* level and are therefore better to compare and combine.

<<< Matthias Meier >>>



(in)accuracy	*(Un)Genauigkeit*
acceleration // əkˌselə'reɪʃn	*Beschleunigung*
attempt	*Versuch, Anlauf*
circumference // sə'kʌmfərəns	*Umfang*
conduct, to // kən'dʌkt	*durchführen, vornehmen*
confidence	*Vertrauen*
consistent	*übereinstimmend, vereinbar, stetig*
contain, to	*enthalten, beinhalten*
contemporary // kən'tɛmprəri	*heutig, zeitgemäß*
contribute, to	*beisteuern, beitragen*
conversion table	*Umrechnungstabelle*
degree	*Grad, Maß*
destination	*Ziel*
detect, to	*erfassen*
distribution	*Verteilung*
elaborate // ɪ'læbərət	*durchdacht, aufwendig*
elevation	*Höhe, Höhenangabe*
ensure, to	*sicherstellen, garantieren*
environmental // ɪnˌvaɪrən'mentl	*Umgebungs-*
equipment	*Gerät, Apparatur, Ausrüstung*
faulty	*fehlerhaft, defekt*
folding rule	*Gliedermaßstab, Klappmeter*
girder // 'gɜːdə	*Träger*
humidity // hjuː'mɪdəti	*Feuchtigkeit, Luftfeuchte*
jaw //	*Backe*
margin	*Spanne, Spielraum*
metrology // mə'trɔlədʒi	*Messtechnik, Messwesen*
occur, to // ə'kɜː	*sich ereignen*
probability	*Wahrscheinlichkeit*
property	*Eigenschaft*
purpose // 'pɜːpəs	*Zweck, Ziel*
quantify, to	*mengenmäßig bestimmen*
random	*zufällig*
ruler	*Maßstab, Lineal*
shift, to	*verschieben*
skilled	*geschult, qualifiziert*
sophisticated // sə'fɪstɪkeɪtɪd	*ausgeklügelt, hochentwickelt*
spread // spred	*Spanne, Spannweite*
take into consideration, to	*beachten, bedenken*
thrice // θraɪs	*dreimal*
traceability // treɪsə'bɪləti	*Rückverfolgbarkeit*
unavoidable // ˌʌnə'vɔɪdəbl	*unvermeidbar*
uncertainty	*Unsicherheit*
unit	*Einheit*
value	*Wert*
vernier calliper // 'vɜːrnɪər 'kælɪpə	*Schublehre, Messschieber*

Die Zukunft war mal was: entweder das Paradies oder ein Alptraum. In den letzten Jahren jedoch haben wir irgendwie aufgehört, die Zukunft zu verherrlichen oder über sie nachzudenken. Leiden wir an einer „Zukunftmüdigkeit" und haben die Zukunft abgeschrieben? Eine Suche.

THE FUTURE ISN'T WHAT IT USED TO BE

The future used to be something, either paradise or nightmare. *In* recent *years, however, we somehow stopped idealizing or even thinking about the future. Have we reached "future* fatigue*" and given up on the future? A search.*

The future isn't what it used to be, at least *according to* the Canadian science fiction *novelist* William Gibson. In an interview with the BBC, Gibson said people seemed to be losing interest in the future. "All through the 20th century we constantly saw the 21st century *invoked*," he said. "How often do you hear anyone invoke the 22nd century? Even saying it is unfamiliar to us. We've come to not have a future".

Gibson thinks that during his lifetime the future "has been a cult, if not a religion". His whole generation was *seized* by "postalgia". This is a tendency to *dwell on* romantic, idealised visions of the future. Rather than imagining the past as an ideal time as nostalgics do, postalgics think the future will be perfect. For example, a study of young consultants found many *suffered* from postalgia. They imagined their life would be perfect once they were *promoted* to partner.

"The Future, *capital*-F, be it crystalline city on the hill or radioactive post-nuclear *wasteland*, is gone", Gibson said in 2012. "Ahead of us, there is *merely* … more stuff … events". The *upshot* is a *peculiarly* postmodern *malaise*. Gibson calls it "future fatigue". This is a condition where we have grown *weary* of an *obsession* with romantic and *dystopian* visions of the future. Instead, our focus is on now.

Gibson's diagnosis is *supported* by international *attitude surveys*. One found that most Americans rarely think about the future and only a few think about the distant future. When they are *forced* to think about it, they don't like what they see. Another *poll* by the Pew Research Centre found that 44% of Americans were pessimistic about what lies ahead.

But pessimism about the future isn't just limited to the US. One international poll of over 400,000 people from 26 countries found that people in developed countries tended to think that the lives of today's children will be worse than their own. And a 2015 international survey by YouGov found that people in developed countries were *particularly* pessimistic. *For instance*, only 4% of people in Britain thought things were *improving*. This *contrasted* with 41% of Chinese people who thought things were getting better.

UTOPIA OR DYSTOPIA

So why has the world seemingly given up on the future? One explanation might be that deep pessimism is the only rational *response* to the catastrophic consequences of global warming, *declining* life *expectancy* and an *increasing* number of poorly understood existential risks.

But other research *suggests* that this widespread pessimism is irrational. People who support this view, point out that on many *measures* the world is actually improving. And an Ipsos poll found that people who are more informed tend to be less pessimistic about the future.

Although there may be some *objective* reasons to be pessimistic, it is likely that other factors may explain future fatigue. Researchers who have studied *forecasting* say there are good reasons why we might avoid making *predictions* about the distant future.

For one, forecasting is always a highly uncertain activity. The longer the time frame one is making predictions about and the more complicated the prediction, the more room there is for error. This means that while it might be rational to make a projection about something simple in the near future, it is probably *pointless* to make projections about something complex in the very distant future.

Economists have known for many years that people tend to *discount* the future. That means we put a greater *value* on something which we can get *immediately* than something we have to wait for. More attention is paid to *pressing short-term* needs while *longer-term* investments go *unheeded*.

Psychologists have also found that futures that are close at hand seem concrete and detailed while those that are further away seem abstract and stylised. Near futures were more likely to be based on personal *experience*, while the distant future was *shaped* by ideologies and theories.

When a future seems to be closer and more concrete, people tend to think it is more likely to *occur*. And studies have shown that near and concrete futures are also more likely to *spark* us into action. So the preference for concrete, close-at-hand futures mean people tend to *put off* thinking about more abstract and distant possibilities.

The human *aversion* to thinking about the future is partially *hardwired*. But there are also particular social conditions that make us more likely to give up on the future. Sociologists have *argued* that for people living in *fairly* stable societies, it is possible to generate stories about what the future might be like. But in moments of *profound* social *dislocation* and *upheaval*, these stories stop making sense and we lose a sense of the future and how to prepare for it.

This is what happened in many *native American* communities during colonialism. This is how Plenty Coups, the leader of the Crow people, described it: "When the buffalo went away the hearts of my people fell to the ground, and they could not *lift* them up again. After this nothing happened."

But instead of being thrown into a sense of *despair* by the future, Gibson thinks we should be a little more optimistic. "This new found state of No Future is, in my opinion, a very good thing … It *indicates* a kind of *maturity*, an understanding that every future is someone else's past, every present is someone else's future". *<<< Andre Spicer >>>*

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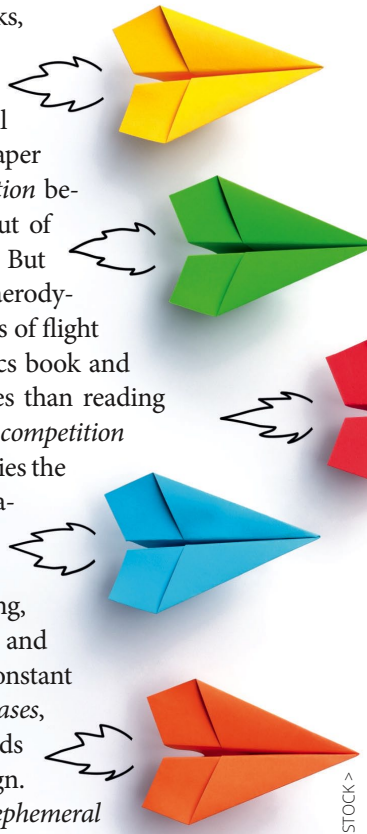
https://theconversation.com/sci-fi-author-william-gibson-how-future-fatigue-is-putting-people-off-the-22nd-century-130335

https://sites.google.com/site/andrespicer
Webseite des Autoren Andre Spicer, Professor für Organisational Behaviour an der Cass Business School, London

according to	*gemäß, nach, laut*
argue, to	*behaupten, argumentieren*
attitude	*Verhalten, Haltung*
aversion // ə'vɜ:ʃn	*Abneigung, Widerwille*
capital // 'kæpɪtl	*hier: Großbuchstabe*
contrast, to	*sich abheben, kontrastieren*
decline, to // dɪ'klaɪn	*abnehmen, sinken, fallen*
despair	*Verzweiflung, Hoffnungslosigkeit*
discount, to	*außer Acht lassen, ignorieren*
dislocation	*Verwerfung, Verlagerung*
dwell on sth., to // dwel	*sich in etw. ergehen*
dystopian // dɪs'təʊpiən	*dystopisch, anti-utopisch*
economist	*Wirtschaftswissenschaftler/in*
expectancy	*Erwartung*
experience	*Erfahrung, Erleben*
fairly	*relativ, ziemlich*
fatigue // fə'ti:g	*Müdigkeit, Erschöpfung*
for instance	*zum Beispiel*
force, to	*drängen, zwingen*
forecasting	*Vorhersage, Prognose*
hardwired	*fest verdrahtet*
immediately	*sofort, unmittelbar*
improve, to	*sich verbessern, besser werden*
increase, to	*zunehmen, ansteigen*
indicate, to	*signalisieren, zeigen*
invoke, to	*beschwören, anrufen*
lift, to	*aufheben, hochheben*
longer-term // ˌlɒŋ 'tɜ:m	*längerfristig*
malaise // mə'leɪz	*Unbehagen, Verstimmung*
maturity // mə'tʃʊərəti	*Reife, Erwachsensein*
measure	*Maß, Maßnahme*
merely // 'mɪəli	*lediglich, nur*
native American	*Ureinwohner/in Amerikas*
nightmare // 'naɪtmeə	*Alptraum*
novelist	*Schriftsteller/in, Autor/in*
objective // əb'dʒektɪv	*sachlich, neutral*
obsession	*Besessenheit, Sucht*
occur, to // ə'kɜ:	*eintreten, passieren, geschehen*
particularly	*besonders, vor allem*
peculiarly // pɪ'kju:liəli	*charakteristisch, besonders*
pointless	*sinnlos, zwecklos*
poll	*Meinungsumfrage, Befragung*
prediction	*Vorhersage, Voraussage*
pressing	*dringlich, akut, drängend*
profound	*tiefgreifend, ausgeprägt*
promote, to	*befördern*
put off, to	*aufschieben, hinausschieben*
recent	*jüngst, kürzlich*
response	*Reaktion, Antwort*
seize, to // si:z	*einnehmen, erfassen, ergreifen*
shape, to	*formen, gestalten*
short-term // ʃɔ:t 'tɜ:m	*kurzfristig*
spark, to	*hier: entfachen, auslösen*
suffer, to	*leiden*
suggest, to // sə'dʒest	*nahelegen, hindeuten*
support, to	*unterstützen, stützen*
survey // 'sɜ:veɪ	*Umfrage, Untersuchung*
unheeded // ʌn'hi:dɪd	*unbeachtet*
upheaval // ʌp'hi:vl	*Umbruch, Umwälzung, Aufruhr*
upshot	*Fazit, Ergebnis*
value	*Wert, Bedeutung*
wasteland	*Wüstenei, Ödnis*
weary // 'wɪəri	*überdrüssig, müde*

PAPER PLANES

In der Schule haben wir beim Falten von Papierfliegern wahrscheinlich mehr über Aerodynamik gelernt als in den Physikstunden, die wir damit torpediert haben. Ein unscheinbares Blatt Papier ist eines der besten und ältesten Technikspielzeuge, die es gibt.



Forget about Lego blocks, *Erector sets* or experimental kits to teach science and technical *skills* – all you need is a piece of paper. Paper planes may have a bad *reputation* because they are usually built out of boredom or to *annoy* teachers. But kids can learn more about aerodynamics and the basic principles of flight by *ripping* pages from a physics book and folding them into paper planes than reading the actual book. The *juvenile competition* to fold the paper plane which flies the furthest, longest or hits the paper basket next to the blackboard teaches kids all about the centre of *gravity*, trimming, *drag* and lift, *control surfaces* and aerodynamics. Besides, the constant experimenting with folds, *creases*, *dog's ears*, *pinches*, rips and bends is a free lesson in iterative design.

Due to the paper plane's *ephemeral* nature its origin is lost in history. It's safe to say, however, that once the Chinese had *invented* paper it probably didn't take long for someone to come up with a more elegant way to *toss* it across a room than *crumpling* it up into a ball. Leonardo da Vinci, the other usual *suspect*, is said to have experimented with paper planes, too. The first written records of the classic paper dart date back to the mid-1800s when it appears in boy's books, school reports – and the rule book of the New York *Stock Exchange*, which lists a *fine* of ten Dollars for the throwing of paper darts. In 1867, J. W. Butler and E. Edwards even received a patent for a paper plane. Later, pioneers of flight like the Wright brothers, Alberto Santos-Dumont or Jack Northrop *honed* their aerodynamic skills with paper planes.

There are a million ways to fold a paper plane and everybody has, of course, their own little design secrets. The *sleek* dart, the slower square-wing or the two-part plane with *inserted* tail are mere starting points. Variants include double-deckers, *canards* or stunt planes. Some designs hardly *resemble* an airplane at all or glide indefinitely and *miraculously* in front of you.

Naturally, there are also serious competitions for paper planes and regular record *attempts*. Guinness World Records lists, among others, the longest flying paper plane (29.6 seconds), the farthest flight (69.14 meters), the largest paper plane (18.21-meter wingspan) and, weirdly, the most paper planes caught by the mouth in one minute (17). The Japanese space agency even *considered* dropping some paper planes from the International Space Station which would have clearly topped the current 35,043-meter record from a weather balloon.

Serious science project or just a little *insurgence* against the teacher – the *humble* paper plane literally starts with a blank piece of paper and can be folded into both of them – or anything in between. Little wonder it's a fixed part of the Ig Nobel Prize for *improbable* research. Before scientists receive their *awards* for the *quirkiest* research paper the *audience* ceremoniously floods the stage with hundreds and hundreds of paper planes – the most improbable of tech toys.

<<< M. Meier >>>

www.foldnfly.com
Beispielhaft nur eine von hunderten von Webseiten mit Papierflieger-Faltanleitungen.

https://youtu.be/C65URTP2qD8
Vortrag von Rekordhalter und "Paper-Airplane-Guy" John Collins.

< PHOTO: PASUWAN/SHUTTERSTOCK >

annoy, to	*nerven, ärgern*
attempt	*Versuch, Anlauf*
audience	*Publikum, Auditorium*
award	*Preis, Auszeichnung*
canard // 'kænɑ:d	*Entenflügler*
competition	*Wettbewerb, Wettstreit*
consider, to	*in Betracht ziehen, erwägen*
control surface // kən'trəʊl 'sɜ:fɪs	*Ruder, Leitwerk (Flugzeug)*
crease // krɪ:s	*Falte*
crumple, to	*zerknüllen, zerdrücken*
dog's ear	*Eselsohr*
drag // dræg	*(Luft-) Widerstand*
ephemeral // ɪ'femərəl	*vergänglich, kurzlebig*
Erector set	*Metallbaukasten*
fine	*Strafe, Bußgeld*
gravity	*Schwerkraft*
hone, to // həʊn	*perfektionieren, verbessern*
humble // 'hʌmbl	*bescheiden, einfach*
improbable // ɪm'prɒbəbl	*absurd, unwahrscheinlich, abwegig*
insert, to	*einsetzen, einfügen*
insurgence // ɪn'sɜ:dʒəns	*Aufstand, Rebellion*
invent, to	*erfinden, ausdenken*
juvenile // 'dʒu:vənaɪl	*jugendlich, kindisch*
miraculously // mɪ'rækjələsli	*wunderbarerweise*
pinch	*Kniff, Einschnürung*
quirky // 'kwɜ:ki	*skurril, sonderbar, schräg*
reputation	*Ruf, Ansehen*
resemble, to	*ähneln, aussehen nach*
rip, to	*reißen*
skill	*Fähigkeit, Können*
sleek	*schnittig, schlank*
stock exchange	*Wertpapierbörse*
suspect // 'sʌspekt	*Verdächtige/r*
toss, to	*werfen, schleudern*

FLOW CHAT

Read the short conversation below. Find alternatives for the parts in bold from the box at the bottom.

//// ANSWERS ON PAGE 59 ////

Hi Steve, Pete here. We need to ___ **get together** to discuss the product launch.

I've been thinking the same myself. ___ **Do you have a date in mind?**

This month is rather hectic, but I ___ **could make it** on Wednesday 16th or the afternoon of the 19th.

Sorry, I'm ___ **busy** on both days. But the following week looks a possibility.

OK. How about the Wednesday? I'm free all day.

___ **That suits me, too**. Is there anyone else ___ **we should invite?**

I think Alex should be there. He was responsible for ___ **preparing** the budget so he has all the figures.

Right. Anyone else?

I'd like to keep it small this time. ___ **Do you want to come here or shall I come to you?**

___ **It doesn't really matter**. It might make more sense for me to come to you as your office is about half way for me and Alex.

Fine. How about 9 o'clock? ___ **That would give us** a few hours before lunch and we could continue afterwards if necessary?

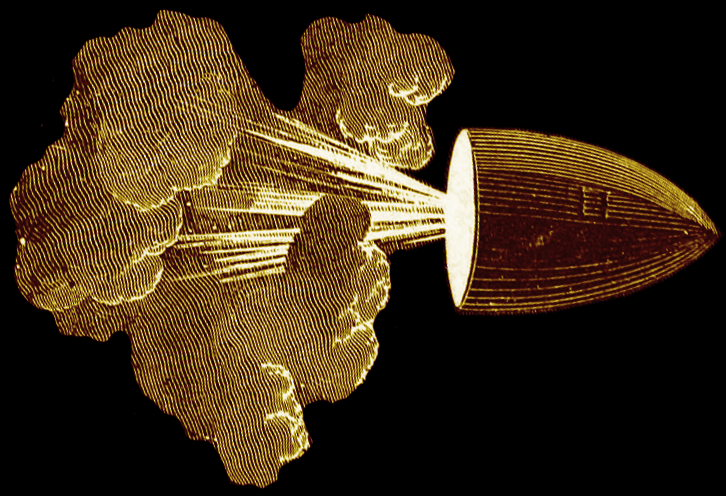
And if Alex ___ **can't make that date**, when else could we meet?

The following week I could make Monday afternoon or Thursday morning.

If necessary, I could ___ **be free then**, too.

OK, I'll call Alex and see if he's free.

A	is unavailable	**G**	we would then have
B	re-arrange my appointments	**H**	where's the best place to meet
C	fine by me	**I**	meet up
D	drawing up	**J**	who needs to be there
E	any thoughts as to when	**K**	no preference, really
F	have time	**L**	tied up



< PHOTOS: NASA | ILLUSTRATIONS: ÉMILE-ANTOINE BAYARD >

Vor fünfzig Jahren wurde aus der Handlung von Jules Vernes Roman "Von der Erde zum Mond" Wirklichkeit: Der Flug von Apollo 8 zum Mond war die gewagteste Mission des ganzen Mondprogramms – und überraschend nah an Vernes Skript.

FROM THE EARTH TO THE MOON

50 years ago, the plot *of Jules Verne's* novel *"From the Earth to the Moon" became a reality: Apollo 8's flight around the Moon was the* boldest *mission of the whole Moon program – and* surprisingly *close to Verne's script.*

"Let there be light: and there was light." The Book of *Genesis* may not be your *average* Christmas story but what do you say when it's *Christmas Eve* 1968 and you are the first humans in orbit around the Moon? Frank Bormann, Jim Lovell and Bill Anders, the astronauts of Apollo 8, had been asked to comment on the first live images from the Moon with something "*appropriate*" – after all, about a sixth of the World's population would be *tuning in*. What could be more appropriate to *accompany* the passing *Moonscape* below than the first verses of the Book of Genesis about the light and the dark?

Some criticised the religious nature of the *broadcast* but anyone *venturing* out this far should be forgiven for *calling upon their faith*. Apollo 8 was, without *doubt*, the most *daring* mission of the entire Moon program – compared to its risks and *uncertainties*, the actual Moon landing of Apollo 11 was almost anti-climactic.

NASA's Moon program was a well-planned, step-by-step *approach* with each mission of the Mercury, Gemini and Apollo program adding another *capability* necessary to land on the Moon. Apollo 8's *initial* mission was to test the *lunar module* in Earth orbit. A *sensible objective* given the fact that this would be the very first crewed flight of the mighty Saturn V, the largest and most powerful rocket ever built. The Apollo spaceship at the top was also rather new: only one crew had flown it before. The lunar module's *assembly*, however, was way behind *schedule* and NASA was under huge pressure: In September 1968, the Soviets had sent two *tortoises* and a few *mealworms* around the Moon and returned them safely to the Earth – surely cosmonauts

would be next. To win the space race the mission planners had to slightly change the *destination* for Borman, Lovell and Anders: They were to *take* their brand new *ride for a spin* around the Moon.

The *decision* was unbelievably bold *considering* that no spaceship of the Moon program had ever left Earth's orbit. Apollo 6, an *uncrewed* Saturn V test flight, was *designated* to go around the Moon, but the third *stage failed* to restart its engines for trans-lunar *injection* and the mission was literally cut short. When, on the 21st December 1968, Borman, Lovell and Anders lifted off on the Florida coast from John F. Kennedy Space Centre's *pad* 39 A they were the first humans to leave the relative safety of Earth's orbit and travel 400,000 kilometres out into the unknown.

Three days later, on 24th December 1968, Apollo 8 disappeared behind the Moon. No human had ever directly *observed* the *far side* of the Moon but the crew had little time to *appreciate* it. Without any contact to the ground station, they had to precisely time the engine burn for lunar orbit *insertion* – too short and Apollo 8 would be *flung* off into space, too long and it would become another crater on the Moon. For the astronauts these four minutes and seven seconds felt like an *eternity*.

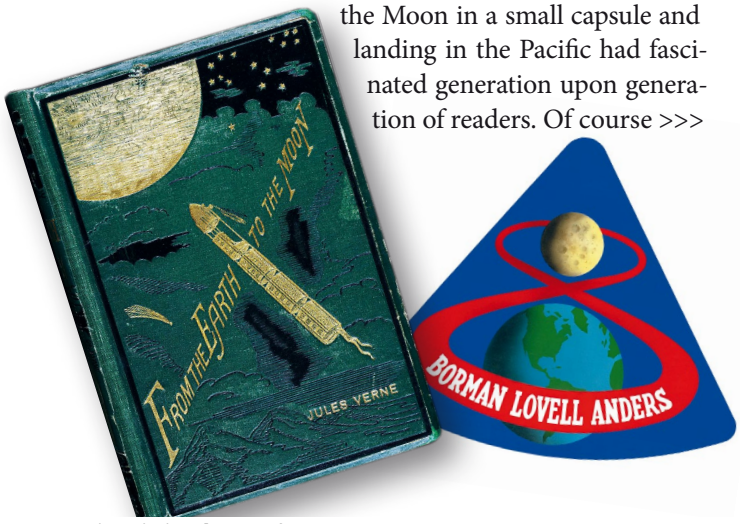
Once in orbit, there was little to do except to read the Bible and take hundreds of photos – among them the iconic image of the *distant* Earth rising above the *barren* Moon.

After 20 hours in orbit, it was time to leave. Another critical engine burn and Borman, Lovell and Anders were on their way back to the "good Earth". On 27th December, three giant *parachutes* opened over the North Pacific south of Hawaii. Apollo 8 safely *splashed* into the waters and was picked up by an *aircraft carrier*.

What an adventure, what a story. A story that had already been told a hundred years before by a *certain* Jules Verne. NASA, it seemed, was *merely* following his script.

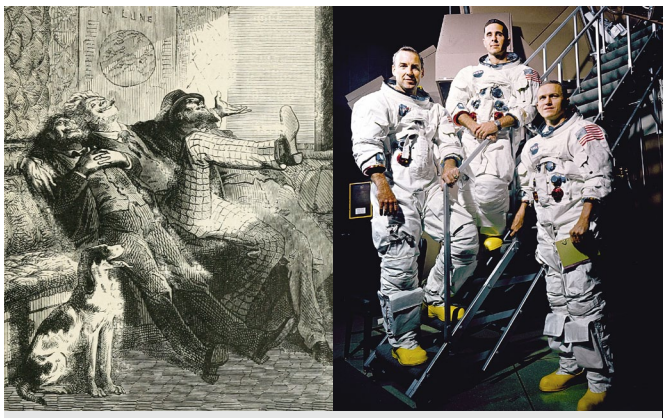
MODERN TAKE ON AN OLD IDEA

In 1865, Jules Verne had written the novel "From the Earth to the Moon" followed by the 1870 *sequel* "Around the Moon". His *tale* of three men taking off from Florida, flying around the Moon in a small capsule and landing in the Pacific had fascinated generation upon generation of readers. Of course >>>



accompany, to	*begleiten*
aircraft carrier	*Flugzeugträger*
appreciate, to // ə'pri:ʃieɪt	*würdigen, schätzen*
approach // ə'prəʊtʃ	*Ansatz, Herangehensweise*
appropriate	*angemessen, passend*
assembly	*Montage, Zusammenbau*
average // 'ævərɪdʒ	*gewöhnlich, durchschnittlich*
barren	*karg, brach, öde*
bold (bolder, boldest)	*mutig, gewagt, kühn*
Book of Genesis // 'dʒenəsɪs	*Schöpfungsgeschichte*
broadcast	*Übertragung, Sendung*
call upon one's faith, to	*seinen Glauben anrufen*
capability	*Fähigkeit*
certain	*bestimmt, gewiss*
Christmas Eve	*Heiligabend*
consider, to	*betrachten, erachten*
daring	*gewagt, tollkühn, waghalsig*
decision	*Entscheidung, Entschluss*
designate, to	*bestimmen*
destination	*(Reise-) Ziel, Bestimmung*
distant	*entfernt, fern*
doubt // daʊt	*Zweifel, Bedenken*
eternity // ɪ'tɜ:nəti	*Ewigkeit*
fail, to	*versagen, verfehlen*
far side	*erdabgewandte Seite (des Mondes)*
fling, to (flung, flung)	*schleudern, werfen*
initial // ɪ'nɪʃl	*ursprünglich*
injection	*Eindüsung, hier etwa: Einschwenkmanöver*
insertion // ɪn'sɜ:ʃn	*Einbringen, Einführung*
lunar module	*Mondlandefähre*
mealworm	*Mehlwurm*
merely // 'mɪəli	*nur, bloß, lediglich*
Moonscape	*Mondlandschaft*
novel // 'nɒvl	*Roman*
objective // əb'dʒektɪv	*Zielsetzung, Mission*
observe, to	*beobachten*
pad	*hier: Abschussrampe*
parachute // 'pærəʃu:t	*Fallschirm*
plot	*hier: Handlung*
ride	*hier etwa: fahrbarer Untersatz*
schedule // 'ʃedju:l	*Zeitplan*
sensible	*sinnvoll, vernünftig*
sequel // 'si:kwəl	*Fortsetzung*
splash, to	*platschen*
stage // steɪdʒ	*Stufe*
surprisingly	*überraschenderweise*
take sth. for a spin, to (took, taken)	*mit etw. eine Spritztour machen*
tale	*Geschichte, Erzählung*
tortoise // 'tɔ:təs	*Schildkröte*
tune in, to	*einschalten (z. B. in e. Programm)*
uncertainty	*Unsicherheit, Ungewissheit*
uncrewed	*ohne Besatzung, unbemannt*
venture, to // 'ventʃə	*wagen, riskieren*

It took a little over a hundred years before the dream of a journey to the moon became true: Jules Verne's book was published in 1865 and Apollo 8 launched in December 1968.



Even the names of Jules Verne's moon travellers – Ardan, Barbicane and Nicholl – sound similar to Anders, Borman and Lovell, the crew of Apollo 8.

there had been other Moon travelling stories before – Johannes Kepler's "Dream" or Edgar Allan Poe's "The Unparalleled Adventure of One Hans Pfaall", for example – but they all *employed* rather *dubious* methods to get to the Moon like eagles, demons or balloons. Verne's *account*, in contrast, is detailed, almost scientific – and, at times, *uncannily* close to the actual flight of Apollo 8.

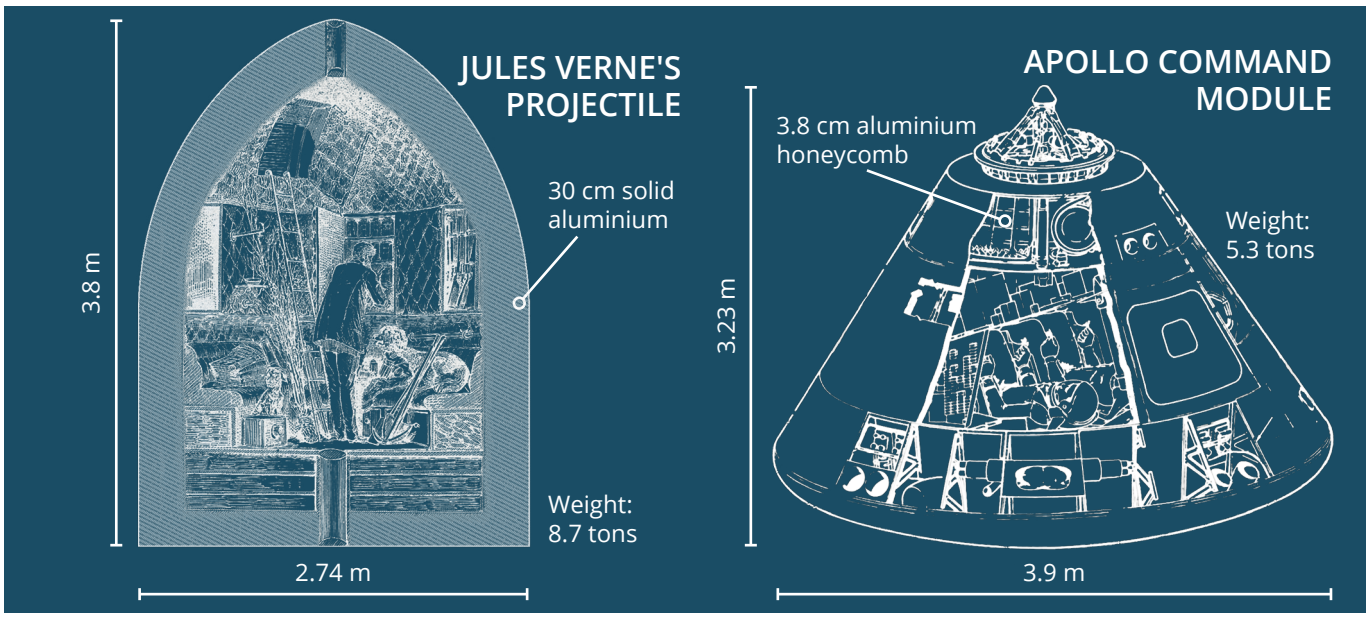
Take the basic storyline, for example: In both cases there are three Moon travellers. Verne calls them Ardan, Barbicane and Nicholl, which sounds *eerily* similar to Anders, Borman and Lovell. In 1865, they take off from Tampa, some 185 kilometres away from the *space port* at Cape Canaveral. They travel for ten instead of Apollo 8's six days and touch down in the Pacific to be *recovered* by a Navy *vessel*.

Want more? How about the fact that the *spacecraft* Verne describes has about the same dimensions as the Apollo 8 command and service module, *weighs* about the same and is also made of aluminium. Both vessels are *equipped* with absorbers to *scrub carbon dioxide* out of the air and special *couches* to *ease* the *G-loads* for the astronauts at *lift-off*. The list goes on, even the cost of the program *estimated* by Verne is similar to the 14 billion US dollars which had been spent up to the Apollo 8 mission.

How was Jules Verne able to *predict* all this so precisely? After all, he was *neither* a scientist *nor* an engineer. Born on 8th February 1828 in Nantes, France, Jules Gabriel Verne first studied *law* but soon quit to become a writer under the *mentorship* of Alexandre Dumas. Despite his career choice, Verne was fascinated by the numerous technical innovations and expeditions of his time. He *earned* some money on the side with scientific and historical short stories which were *meticulously researched* and highly *appealed* to the *mindset* of the era's technological boom. For the publisher Pierre-Jules Hetzel, Jules Verne was the perfect man for a new magazine he had in mind combining *entertaining* fiction with scientific education. The two were the perfect team – together, they would publish over 60 novels.

COMBINING SCIENCE AND FICTION

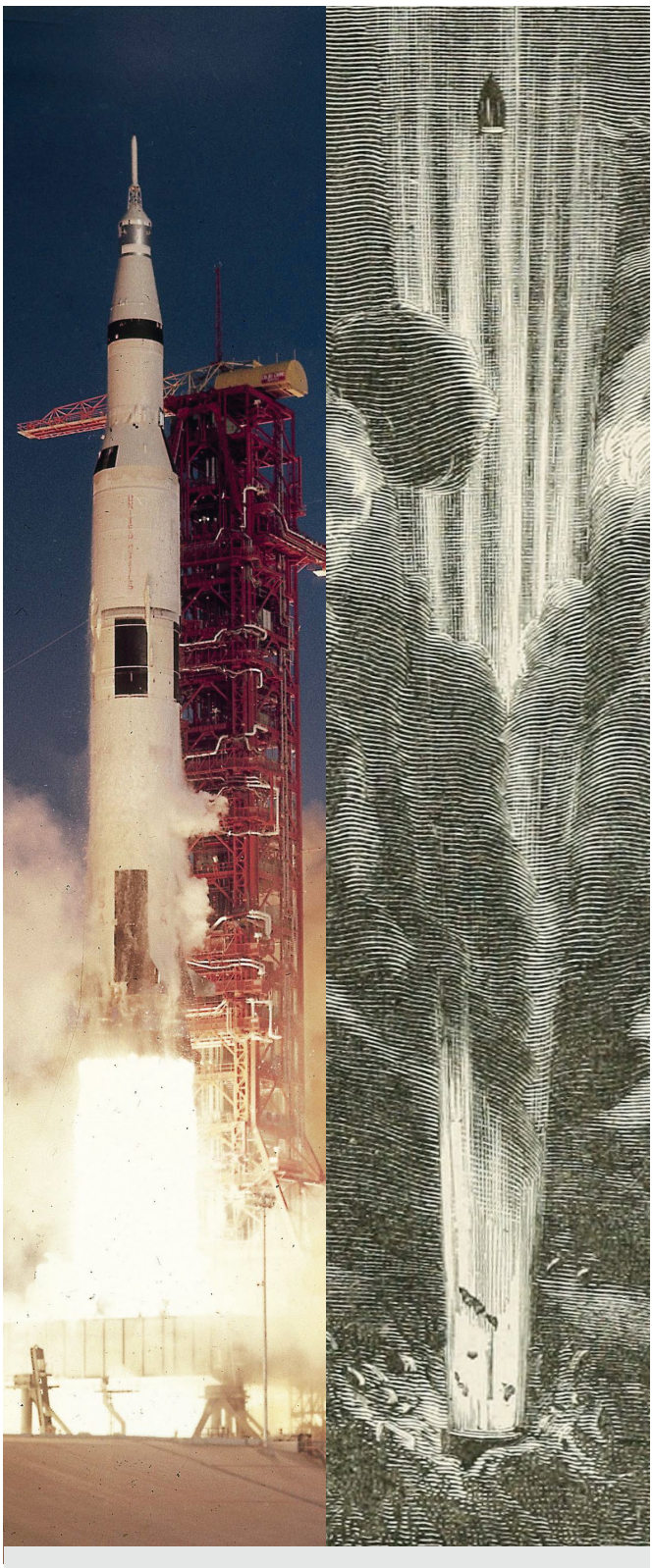
Although "From the Earth to the Moon" was only Verne's third novel, it was *nonetheless* entirely based on the latest scientific *discoveries*. The first *issues* even included an extra chapter with Moon facts, formulas and calculations! Combining and *extrapolating* these facts, Verne *inevitably* followed a similar line of thought as the NASA engineers one hundred years later. Like them, he *pondered* that at a *launch* site close to the Equator, i.e. Florida, the Earth's rotation would add extra speed and that landing in the ocean water would soften the landing. And just like Verne, the NASA engineers *applied* Newton's and Kepler's laws to calculate the *escape velocity* from Earth to about 11 km/s or predict *weightlessness* – although Verne thought his Moon travellers would only *float* at the Lagrange point where the *gravity* of the Earth and the Moon balance each other.



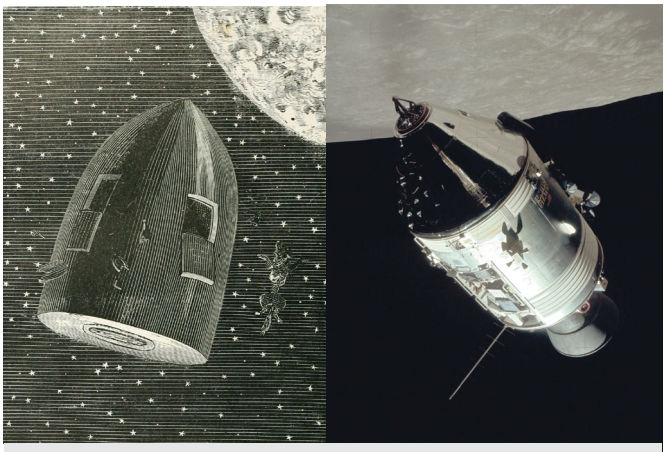
This wasn't Verne's only mistake, of course: He let his *protagonists peek* outside the window during their journey to the Moon and didn't *bother* about parachutes to break their fall back to Earth. The most *striking deviation* from NASA's plan to get to the Moon, however, is the giant Moon cannon.

In Verne's books the Baltimore Gun Club *casts* 60,000 tons of *iron* into the ground to form the Columbiad – a 274-meter-long *behemoth* of a cannon with two-meter-thick walls to resist the *blast* of 200 tons of *gun cotton*. >>>

account	*Bericht, Darstellung*
appeal, to	*gefallen, Anklang finden*
apply, to	*anwenden, einsetzen*
behemoth // bɪ'hiːməθ	*Gigant, Koloss*
blast	*Explosion, Druckwelle*
bother, to	*sich kümmern, plagen*
carbon dioxide // ˌkɑːbən daɪ'ɒksaɪd	*Kohlendioxid*
cast, to	*gießen*
couch	*Liege*
deviation	*Abweichung*
discovery	*Entdeckung*
dubious // 'djuːbiəs	*zweifelhaft, fragwürdig*
earn, to	*verdienen*
ease, to	*lindern, mildern*
eerily // 'ɪərəli	*gespenstisch, unheimlich*
employ, to	*einsetzen, sich bedienen*
entertain, to	*unterhalten*
equip, to	*ausrüsten, ausstatten*
escape velocity	*Fluchtgeschwindigkeit*
estimate, to	*schätzen, veranschlagen*
extrapolate, to	*hochrechnen*
float, to	*schweben*
G-load	*Schwerkraftbelastung*
gravity	*Schwerkraft*
gun cotton	*Schießbaumwolle*
inevitably // ɪn'evɪtəbli	*zwangsläufig, unausweichlich*
iron // 'aɪən	*Eisen*
issue // 'ɪʃuː	*Ausgabe, Nummer, Heft*
launch // lɔːntʃ	*Start*
law	*hier: Jura*
lift-off	*Start, Abheben*
mentorship	*Mentorat*
meticulously // mə'tɪkjələsli	*sorgfältig, akribisch*
mindset	*Mentalität, Geisteshaltung*
neither … nor	*weder ... noch*
nonetheless // ˌnʌnðə'les	*nichtsdestotrotz, dennoch*
peek, to	*gucken, nachsehen*
ponder, to	*überlegen, nachdenken*
predict, to	*vorhersagen, voraussagen*
protagonist // prə'tægənɪst	*Hauptfigur, Akteur(in)*
recover, to	*bergen*
research, to	*recherchieren*
scrub, to	*auswaschen, zurücknehmen*
space port	*Weltraumhafen*
spacecraft	*Raumschiff*
striking	*auffallend, eklatant*
uncannily	*unheimlich*
vessel // 'vesl	*Schiff*
weigh, to	*wiegen*
weightlessness	*Schwerelosigkeit*



Jule Verne's moonshot was, literally, a shot from a 274-meter-long cannon. He might have predicted submarines, helicopters and television but to come up with something like the Saturn V, a 111-meter-tall rocket filled with some 2,700 tons of highly explosive fuel, was way beyond even Verne's extremely vivid imagination.



The similarities between Émile-Antoine Bayard's original illustrations and photos from the Apollo space program are striking.

Luckily, the Apollo engineers didn't follow this part of Verne's script because, quite *obviously*, *accelerating* a projectile from zero to 11 km/s over the cannon's length would *squish* the pilots to *pulp*, after which air *friction* would burn them to ash. Verne was aware of the problem, he even has one of his protagonists discuss it – but to come up with something like the Saturn V, a 111-meter-tall rocket filled with some 2,700 tons of highly explosive fuel, was way *beyond* even Verne's extremely *vivid imagination*.

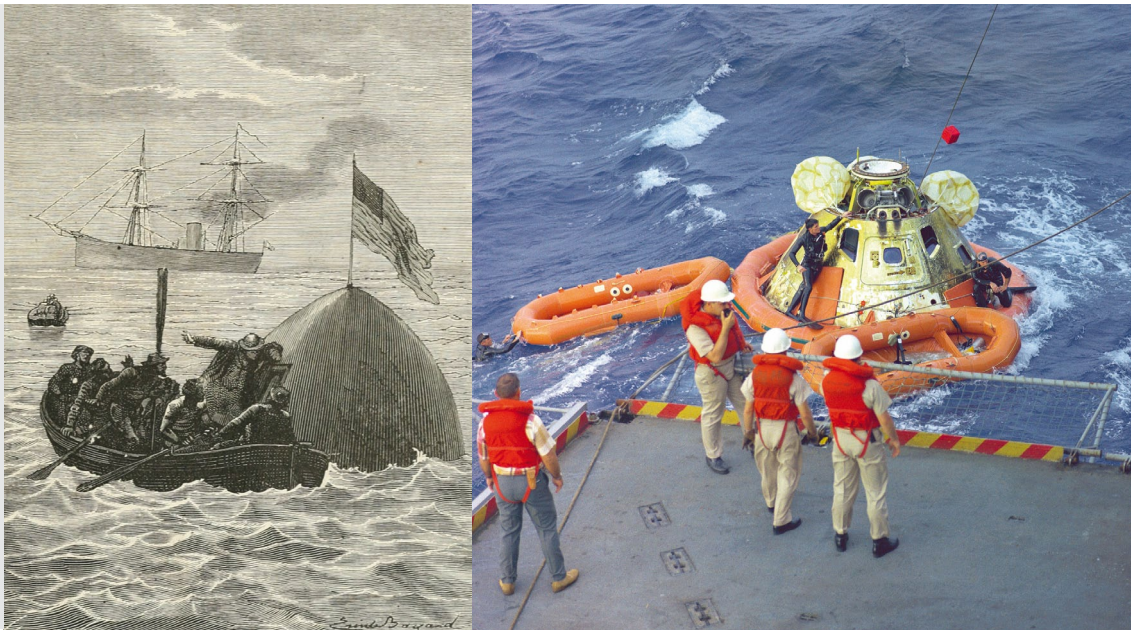
In the mid 19th century, rockets were considered *mere* toys compared to big *bore* cannons – no way could they *propel* something to the Moon. Still, Jules Verne didn't *dismiss* rockets completely. His Moon travellers *intended* to soften their Moon landing with them and ultimately used them as *retro-rockets* to adjust their course after an *encounter* with an asteroid had changed their *trajectory*.

Verne's Moon cannon might be *ridiculously* oversized and impractical to *launch* humans into space but the concept itself is not as crazy as it sounds. In the 1960s, the Canadian engineer Gerald Bull worked on a space gun. With the help of a *spare* battleship gun, his Project HARP ultimately managed to launch a projectile to an *altitude* of 180 kilometres – a record that stands to this day. While the shot definitely reached space, it *achieved* only less than half the speed necessary to stay in orbit. Others followed in Bull's footsteps experimenting with electromagnetic *railguns*, light gas guns or slingatrons but so far no-one has managed to reach the magic 11 km/s. *Efforts* continue; the *appeal* of cheaply launching G-resistant *payloads* into orbit is just too great. Until the engineers *succeed* we have to rely on nature to create a "verneshot" – an actual geological *term* for a volcanic eruption *fierce* enough to launch rocks into space.

A REAL VERNESHOT

Geologists are not the only ones who took inspiration from Jules Verne's "From the Earth to the Moon". Jacques Offenbach turned it into music in his operetta "Le voyage dans la Lune" and film pioneer Georges Méliès used parts of the plot as a script for the first science-fiction movie. Also, many engineers *refer to* Jules Verne as their inspiration – despite the obvious *lapse* with the gun. *On the contrary*, rocket pioneers Konstantin Tsiolkovsky and Hermann Oberth as well as space travellers Juri Gagarin and Neil Armstrong all *admitted* that they had been highly influenced by Jules Verne's tale. The crew of Apollo 11 even named their command and service module "Columbia" in honour of Verne's giant cannon. It was the "Columbia" which, on 20th July 1969, released the famous lunar lander "Eagle". Finally, after one hundred years, Jules Verne and all who had shared his dream had reached the Moon.

<<< Matthias Meier >>>



A landing in the Pacific, boatmen, a Navy vessel as a recovery ship and the American flag – either Jules Verne could indeed look into the future or NASA was merely following his script.

accelerate, to // ək'seləreɪt	*beschleunigen*
achieve, to // ə'tʃi:v	*erreichen, erlangen*
admit, to	*zugeben, eingestehen*
altitude	*(Flug-) Höhe*
appeal // ə'pi:l	*Reiz, Attraktivität*
beyond	*jenseits, außerhalb*
bore	*Kaliber, Bohrung*
dismiss, to	*verwerfen, abtun*
effort	*Versuch, Bemühung*
encounter	*Begegnung, Treffen*
fierce // fɪəs	*heftig*
friction	*Reibung*
imagination	*Einbildungskraft, Phantasie*
intend, to	*vorsehen, beabsichtigen*
lapse // læps	*Fehltritt, Aussetzer*
launch, to // lɔ:ntʃ	*starten, abfeuern*
mere // mɪə	*nur, bloß, lediglich*
obviously // 'ɒbviəsli	*offensichtlich, augenscheinlich*
on the contrary	*im Gegenteil*
payload	*Nutzlast*
propel, to	*antreiben*
pulp // pʌlp	*(Papier-) Brei, breiige Masse*
railgun	*Schienengeschütz*
refer to, to	*sich berufen auf, verweisen*
retro-rocket	*Bremsrakete*
ridiculously // rɪ'dɪkjələsli	*lächerlich, albern*
spare	*Ersatz, Reserve*
squish, to // skwɪʃ	*zerquetschen, zermatschen*
succeed, to	*erfolgreich sein, gelingen*
term // tɜ:m	*Begriff, Wort*
trajectory // trə'dʒektəri	*Flugbahn*
vivid // 'vɪvɪd	*lebhaft, blühend*

https://newatlas.com/apoll-8-45th-anniversary/29991
Sehr ausführliche Beschreibung des Flugs von Apollo 8.

www.welt.de/geschichte/article137533617/Schon-vor-150-Jahren-begann-die-Raumfahrt.html
Zusammenfassung der beiden Bücher von Jules Verne und ihr literarischer Kontext.

http://gutenberg.spiegel.de/buch/von-der-erde-zum-mond-4027/2
http://gutenberg.spiegel.de/buch/reise-um-den-mond-7131/1
"Von der Erde zum Mond" und "Reise um den Mond" zum Nachlesen.

www.spektrum.de/magazin/jules-verne-ein-verkannter-visionaer/824171
Umfassender deutscher Artikel über das Leben von Jules Verne.

www.astronautix.com/j/julesvernemoongun.html
Interessanter Vergleich zwischen Vernes Projektil und den Apollo Raumschiffen.

https://howwegettonext.com/space-guns-fa2dda0561ec
Gute Zusammenfassung zum Thema Space Guns.

Links, Vokabeln & mehr unter
www.inchbyinch.de/inch19/verne

TECH EXTRAS

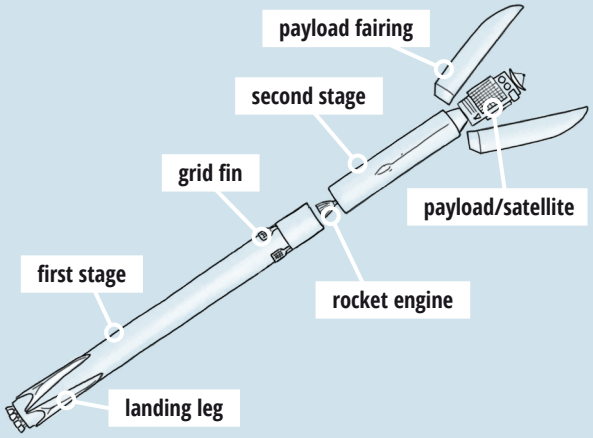
HOW **RAILGUNS** WORK

A *railgun* uses electric *current* instead of explosives to *propel* a projectile. It *consists of* two parallel *rails* made from *conductive* metal and a moving *armature* bridging the *gap* between the rails. When the railgun is fired, an electric current runs from the positive *terminal* of a *power supply* up one rail, across the armature, and down the other rail back to the negative terminal.

The current flowing through the rails creates a magnetic field around them. Since the current in the moving armature flows *perpendicular* to the rails according to the so-called "right-hand rule", the Lorentz force *pushes* it forward. The system is as simple as it is effective: Given large enough currents – on the order of a million Amperes – the armature can *accelerate* projectiles to speeds of up to Mach 5 and higher.

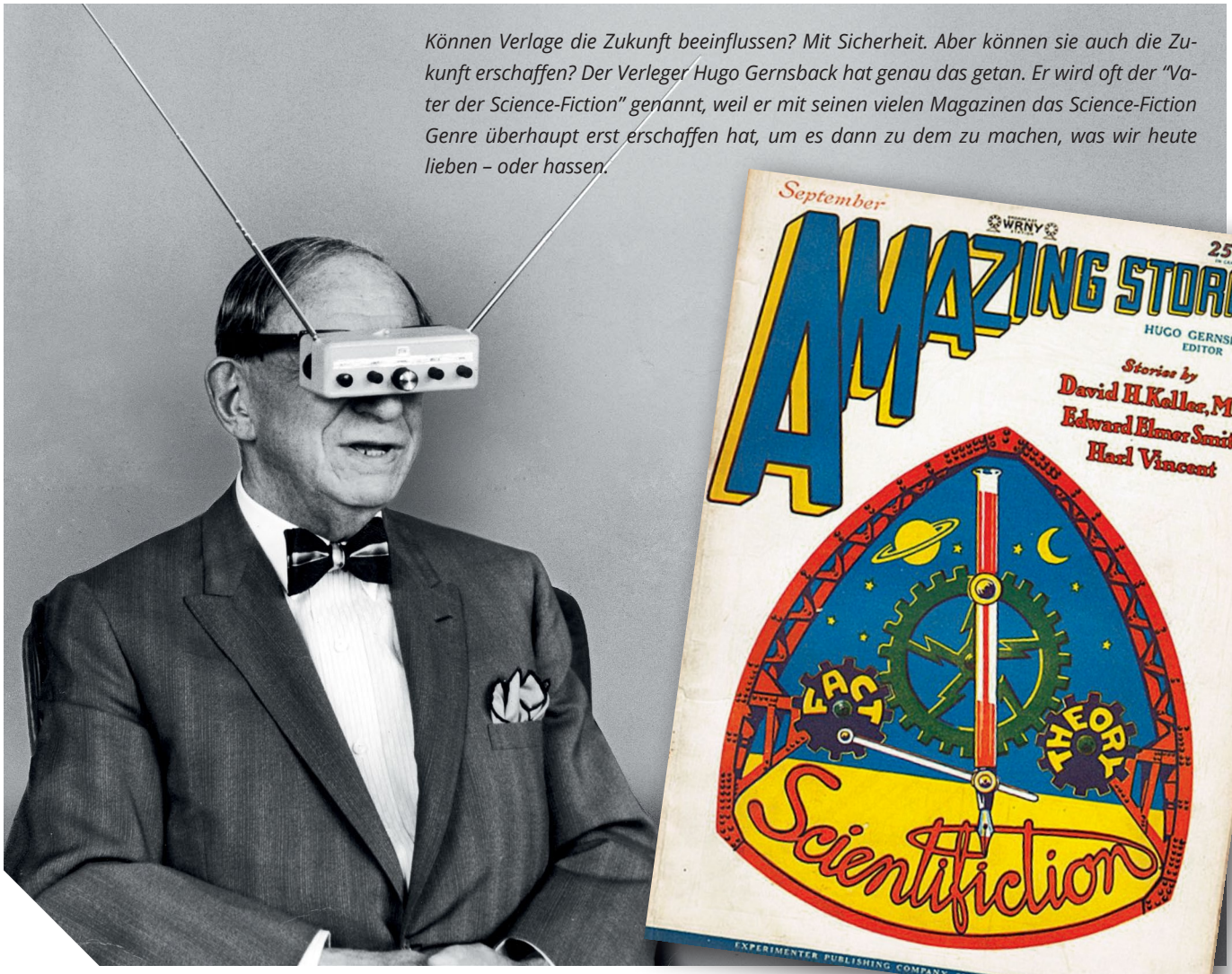
Despite their simplicity, there are currently no practical railguns. They *require* strong power sources and large *capacitors*. *Wear* is also a problem since the strong currents heat up the rails while at the same time pushing them apart.

PICTORIAL **ROCKET**



accelerate, to // ək'seləreɪt	*beschleunigen*
armature // 'ɑ:mətʃə	*Läufer, Anker*
capacitor // kə'pæsɪtə	*Kondensator*
conductive	*leitfähig*
consist of, to	*bestehen aus*
current // 'kʌrənt	*Strom*
gap // gæp	*Zwischenraum, Spalt*
perpendicular // ˌpɜ:pən'dɪkjələ	*rechtwinklig*
power supply	*Stromversorgung*
propel, to	*antreiben*
push, to	*schieben, drücken*
rail	*Schiene*
railgun	*Schienengeschütz*
require, to	*bedürfen, erfordern*
terminal // 'tɜ:mɪnl	*Pol, Anschluss*
wear // weə	*Abnutzung, Verschleiß*

Können Verlage die Zukunft beeinflussen? Mit Sicherheit. Aber können sie auch die Zukunft erschaffen? Der Verleger Hugo Gernsback hat genau das getan. Er wird oft der "Vater der Science-Fiction" genannt, weil er mit seinen vielen Magazinen das Science-Fiction Genre überhaupt erst erschaffen hat, um es dann zu dem zu machen, was wir heute lieben – oder hassen.



< PHOTO: ALFRED EISENSTAEDT/THE LIFE PICTURE COLLECTION/GETTY IMAGES >

THE AMAZING HUGO

Can publishing *shape the future? Most certainly. But can it actually create the future? The* publisher *Hugo Gernsback did exactly that. He is often called "the father of Science Fiction" since his many magazines helped to create and* establish *the genre of Science Fiction as we know, or* loathe, *it today.*

Chances are that, as an engineer, you have read – and enjoyed – at least a few science fiction stories. Maybe you are even a massive SF fan who can *quote* the *'Hitchhiker's Guide to the Galaxy'* from memory and looks forward to the next superhero *blockbuster*. As a matter of fact, today, science fiction is more popular than ever with a massive and *ardent* followership organising international *conventions* and writing fan art. There was a time, however, when there was, quite literally, no 'science fiction'.

Of course there have always been *imaginative* writers who *envisioned* what our technology and our lives might be in ten, a hundred, or a thousand years. Their fantastic stories, though, used to be nothing more than a *fringe* literary category which didn't even have a name. It took a publisher to bring these writers together, give the genre its name, build a *fandom* and community around it and *thereby* lay the groundwork for the mass phenomenon Sci-Fi is today. Hugo Gernsback was the 'man who *invented* the future' … and a few other things along the way. We are getting ahead of ourselves – but isn't this the point of science fiction?

SCIENCE AND FICTION IN LUXEMBOURG

The future, or at least Gernsback's life, began on August 16, 1884, in Luxembourg City. As a child he loved to experiment with *light bulbs*, *buzzers* and telephone sets. All things electric would become his life-long *passion* – just like sci-

entific speculation. *Legend has it* that, after reading Percival Lowell's book 'Mars as the *Abode* of Life', young Hugo fell into a two-day delirium constantly *babbling* about Martian technology. After studying electrical engineering in Bingen, Germany, he was ready to '*explore* strange new worlds' on his own and bought a ticket to the United States. Just 19 years old and with little more than the *proverbial* 'handful of Dollars' and the design for an *improved* dry cell battery in his pocket, he set out to try his luck.

The battery didn't really work out but when he *sought* parts for his next project, the Telimco *Wireless* Telegraph, he got the idea to set up a *mail order company* for electronic parts from Europe to *supply* early radio amateurs. In 1905, electronics, but wireless transmission in particular, were *all the rage* and so his telegraph, which did little more than wirelessly ring a bell, and his 'Electro Importing Company' became a huge *success*.

To *boost* business and educate his radio amateur *customers* Gernsback began to include technical articles and essays in his mail order catalogue. In 1908, this became 'Modern Electrics', the first of many, many magazines Gernsback would *publish*. The magazine and its *successors* as well as 'Radio News', founded in 1919, became somewhat of a playground for Gernsback where he could finally combine and *indulge* in his two passions: radio and future technology.

RADIO, TV AND THE FUTURE

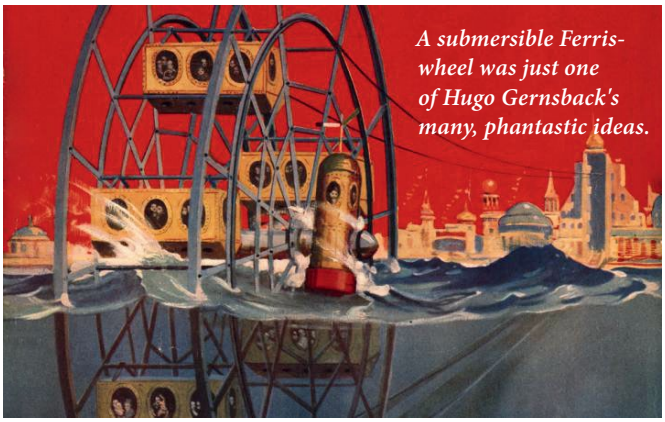
Through his publishing business Gernsback became a *pivotal* figure in promoting the young medium of radio to the public. He *conversed* with Marconi and Edison, was a good friend of Nicola Tesla and even signed up Lee De Forest and John Ambrose Flemming, both early developers of the *vacuum tube*, as authors.

In his magazines he printed *circuit diagrams* and drawings to turn radio listeners into radio experimenters, published lists of radio enthusiasts to build up a community and *founded* several radio organisations. He lobbied for the rights of private radio operators and helped shape the first Radio Act of 1912, which regulated frequency use.

From 1925 on, Gernsback even operated his own radio station, WRNY. While he mainly used the station to promote his magazines and *vice versa* it also *provided* him with the *means* to experiment with what he thought would be the next logical step: Television.

As early as 1909 he had published an article called "Television and the Telephot", which described a primitive *yet* complicated TV set and, maybe more importantly, introduced the word 'television' into the English language. The idea of televised images had *stuck* with Gernsback and some 20 years later his station was transmitting pictures before selected shows which could be *received* with *bulky*, home-made TV sets based on a Nipcow disk. WRNY's TV channel was quite *successful* – at its height some 2,000 enthusiasts were >>>

abode // ə'bəʊd	*Wohnsitz, Aufenthaltsort*
all the rage // reɪdʒ	*schwer in Mode, der Hit*
ardent // 'ɑ:dnt	*leidenschaftlich, glühend*
babble, to	*plappern, faseln*
blockbuster	*Kinohit, Kassenschlager*
boost, to	*fördern, ankurbeln*
bulky	*sperrig, voluminös*
buzzer	*Summer*
circuit diagram // 'sɜ:kɪt daɪəgræm	*Schaltplan, Stromlaufbild*
convention	*Tagung, Kongress*
converse, to	*konversieren, sprechen*
customer	*Kunde, Kundin*
envision, to	*sich vorstellen, ausmalen*
establish, to // ɪ'stæblɪʃ	*etablieren, begründen*
explore, to	*erkunden, erforschen*
fandom	*Fangemeinde*
found, to	*gründen, etablieren*
fringe // frɪndʒ	*Rand, Randbereich*
Hitchhiker's Guide to the Galaxy	*Per Anhalter durch die Galaxis*
imaginative // ɪ'mædʒɪnətɪv	*phantasievoll, einfallsreich*
improve, to	*verbessern, optimieren*
indulge, to // ɪn'dʌldʒ	*schwelgen, nachgehen*
invent, to	*erfinden, ausdenken*
legend has it // 'pæʃn	*einer Legende zufolge*
light bulb	*Glühbirne*
loathe, to // ləʊð	*hassen, verabscheuen*
mail order company	*Versandhandel*
means	*Mittel, Wege*
passion	*Leidenschaft*
pivotal // 'pɪvətl	*zentral, ausschlaggebend*
proverbial // prə'vɜ:biəl	*sprichwörtlich*
provide, to	*bieten, liefern*
publish, to	*herausgeben, verlegen*
publisher	*Verleger/in*
publishing	*Verlagswesen*
quote, to	*zitieren*
receive, to // rɪ'si:v	*empfangen*
seek, to (sought, sought)	*suchen, ausfindig machen*
stick, to (stuck, stuck)	*hängenbleiben, anhaften*
success	*Erfolg*
successful	*erfolgreich*
successor	*Nachfolger, Nachfolgerin*
supply, to	*versorgen, beliefern*
thereby	*damit, dadurch*
vacuum tube	*Elektronenröhre*
vice versa // ˌvaɪs 'vɜ:sə	*umgekehrt*
wireless	*drahtlos*
yet	*allerdings, dennoch, zugleich*



A submersible Ferris-wheel was just one of Hugo Gernsback's many, phantastic ideas.

glued to their *stamp-sized* screens. As innovative as this service was, it was also very expensive to operate, which would come back to *haunt* Gernsback not before too long.

Nonetheless, television was one of Gernsback's more practical ideas. The engineer *turned* publisher was also a serial *inventor* – or serial dreamer as some may say. Only a few of his 80 patents were ever realised but he didn't care. In what has been called a "hit-and-run style of brainstorming" his ever creative mind was firing on all cylinders and luckily he had his magazines and station to present them.

His creations include the 'Hypnobioscope', a device to educate people in their sleep, the 'Isolator', a kind of oxygen-fed diving helmet to improve concentration or a '*submersible* amusement device', basically a *Ferris wheel* which would roll into the sea. On a more practical side he imagined radar down to *text-book*-ready descriptions and, strangely enough, *wax epilation*.

AMAZED BY SCIENCE FICTION

In 1911, he combined a *bunch* of ideas into his first *novel*, Ralph 124C 41+ – a romance of the year 2660. The strange title is a word play and reads: "one to foresee for one". While the literary value of the simple love story is generally considered rather low the book still *anticipated* a long list of technological concepts including video conferencing, television, social networking, electrical cars, transcontinental air service, solar power, microfilm, sound movies, synthetic foods, artificial *cloth*, tape recorders and spaceflight.

So much imagination needed a proper *stage* – and a proper name. Stuffing visionary technical and scientific stories in catalogues and electronics magazines simply wouldn't cut it anymore. So, in 1926, Hugo Gernsback published his *arguably* most influential magazine: Amazing Stories, the first ever science fiction magazine.

Pulp fiction magazines – collections of crime, western or love stories printed on cheap paper – had been around for a while but the concept of what Gernsback called "charming romances *intermingled* with scientific fact and prophetic vision" was so new that he had to come up with a word for it. He called these amazing stories 'scientifiction' which soon would *evolve* into the easier to *pronounce* 'science fiction'. While he was technically not the first one to use the *term* he was *undoubtedly* the one who popularized it and, in a time paradox fitting to the subject, thereby created the genre in the first place. Gernsback truly is the "father of science fiction".

Amazing Stories started off as a simple reprinted collection of the 'future' genre's classics – stories from Jules Verne, H.G. Wells or Edgar Allan Poe – *interspersed* with Gernsback's own reflections and a growing amount of original *content*. H.P. Lovecraft was among the *contributors* as was Edgar Rice Burroughs or Philip Francis Nowlan, who wrote his first 'Buck Rodgers' *tales* for Amazing Stories.

The magazine's motto 'Extravagant Fiction Today – Cold Fact Tomorrow' was more than just a *catch phrase*. Plausibility and accuracy were important to Gernsback; he even employed a kind of science *advisory panel* to ensure that the stories and illustrations were as educational as they were entertaining and would stand up to its technologically *savvy* readers.

The concept worked. Amazing Stories rapidly reached a respectable *circulation* of 100,000. But it wasn't just the stories which *contributed* to the success. Part of the magazine was a large discussion section. Along with the readers' comments Gernsback also published their full address. As unthinkable as this *breach* of privacy may be today, it nonetheless allowed readers for the very first time to connect with each other and form a community. It was here, where future SF giants like Arthur C. Clark, Isaac Asimov or Ray Bradbury first met as teenagers, corresponding with each other to exchange ideas and *hone* their skills.

MAGAZINES AND FANDOM

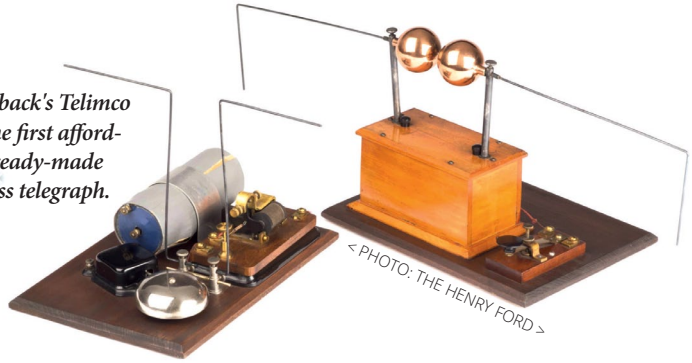
As ground-breaking as Amazing Stories was, Gernsback's *reign* over it was short. By the late 1920s he was in serious financial trouble. Advertisements had dropped significantly, his TV experiments were burning money and there was a great *depression raging* on. Finally, in 1929, he was forced into *bankruptcy* by a *competitor* and lost control over his magazines. It didn't, however, take the *avid* publisher long to *bounce* back. He sold his radio station and electronics business and simply founded a new publishing company which *churned out* magazine after magazine. While Radio Craft and Wonder Stories *competed* directly with his *former* magazines Radio News and Amazing Stories, the long list also included titles such as Scientific Detective Monthly, Aviation Mechanics, Technocracy Review, Motor Camper and Tourist, Popular Medicine or, among the *odder* ones, French Humor and Sexology.

While Gernsback was doing well as a publisher he was never able to replicate the success of Amazing Stories. He was *spreading himself too thin* and, in a way, became a *victim* of his own success. Science Fiction and technology magazines had become widely popular and his many competitors frequently offered better content – probably because they also offered their authors better pay.

In December 1953, Hugo Gernsback published his last SF magazine, *aptly* named Science Fiction +, after which he went into *retirement*. He died on 19th August 1967 in New York – a couple of years too early for the space *funeral* he had always wished for. Instead, in line with his life-long passion, he *donated* his body to science.

During his lifetime, Gernsback never got much *recognition* for what he had *achieved*. He was even criticized for being too fixated on a technology-centred vision of the future, something we now call 'hard science fiction'. It took a while before it became *apparent* that he was much more than >>>

achieve, to // əˈtʃiːv	*erreichen, zustande bringen*
advisory panel	*Beirat, Beratergremium*
amaze, to // əˈmeɪz	*erstaunen, überraschen, verblüffen*
anticipate, to // ænˈtɪsɪpeɪt	*vorwegnehmen, vorhersehen*
apparent // əˈpærənt	*offensichtlich, klar, augenfällig*
aptly // ˈæptli	*treffend, passend*
arguably	*wohl*
avid // ˈævɪd	*rege, eifrig, passioniert*
bankruptcy	*Bankrott, Pleite*
bounce, to	*springen, hüpfen*
breach	*Bruch, Verletzung*
bunch // bʌntʃ	*Haufen, Packen*
catch phrase	*Slogan, Schlagwort*
churn out, to // tʃɜːn	*am laufenden Band produzieren*
circulation	*Auflage*
cloth	*Stoff, Gewebe*
compete, to	*konkurrieren, wetteifern*
competitor	*Wettbewerber/in, Konkurrent/in*
content // ˈkɒntent	*Inhalt*
contribute, to	*beitragen, beisteuern*
contributor // kənˈtrɪbjətə	*Beitragende/r, Mitarbeiter/in*
depression	*Wirtschaftskrise*
donate, to	*spenden, stiften*
evolve, to	*sich entwickeln*
Ferris wheel	*Riesenrad*
former	*früher, ehemalig*
funeral // ˈfjuːnərəl	*Beerdigung, Begräbnis*
glue, to	*kleben, leimen*
haunt, to // hɔːnt	*verfolgen, heimsuchen*
hone, to // həʊn	*verbessern, perfektionieren*
intermingle, to // ˌɪntəˈmɪŋgl	*vermischen, durchsetzen*
intersperse, to // ˌɪntəˈspɜːs	*einstreuen, hier und da einfügen*
inventor	*Erfinder/-in*
novel // ˈnɒvl	*Roman*
odd (odder, oddest)	*seltsam, schräg, skurril*
pronounce, to // prəˈnaʊns	*aussprechen*
pulp fiction // pʌlp ˈfɪkʃn	*Schundliteratur*
rage, to // reɪdʒ	*wüten, toben*
recognition	*Anerkennung*
reign // reɪn	*Herrschaft*
retirement	*Ruhestand, Pension*
savvy // ˈsævi	*kundig, erfahren*
spread oneself too thin, to	*sich verzetteln*
stage	*Bühne, Plattform*
stamp-sized	*briefmarkengroß*
submersible // səbˈmɜːsəbl	*Tauch-, versenkbar*
tale	*Geschichte, Erzählung*
term // tɜːm	*Begriff, Wort*
text book	*Lehrbuch*
turned	*hier: geworden*
undoubtedly // ʌnˈdaʊtɪdli	*unzweifelhaft, zweifellos*
victim	*Opfer, Leidtragende/r*
wax epilation // wæks ˌepɪˈleɪʃn	*Haarentfernung mit Wachs*



Gernsback's Telimco was the first affordable, ready-made wireless telegraph.

< PHOTO: THE HENRY FORD >

just a serial publisher of cheap magazines: a *promoter* of early radio, a TV pioneer, an inventor, a futurist and, above all, the father of Science Fiction magazines and fandom.

Eventually, in 1993, the community he helped to create paid Gernsback a fitting tribute by officially naming the *annual* literary *award* for the best science fiction or fantasy works a 'Hugo' – a *nickname* it had been carrying right from its *inception* in 1953.

Gernsback's many magazines have all *perished*. Today, only Popular Mechanics can *trace* its *ancestry* all the way back to his first publication Modern Electrics. In between these two titles, however, the many Gernsback magazines, their successors and copycats inspired generation upon generation of teenagers to become scientists and engineers. In a way, there's a bit of the amazing Hugo in each of us engineers. *<<< Matthias Meier >>>*

Links, Vokabeln & mehr unter
www.inchbyinch.de/inch27/gernsback

ancestry // 'ænsestri	*Abstammung, Herkunft*
annual	*jährlich, alljährlich*
award // ə'wɔ:d	*Preis, Auszeichnung*
inception // ɪn'sepʃn	*Beginn, Gründung*
nickname	*Spitzname*
perish, to // 'perɪʃ	*untergehen, dahinscheiden*
promoter	*Förderer, Beförderer*
trace, to	*nachvollziehen, verfolgen*

https://web.archive.org/web/20041124090340/http://www.sas.org/tcs/weeklyIssues/2004-09-03/feature1
Große Biographie von Micheal A. Banks, die leider nur noch über die Wayback Machine abzurufen ist.

www.swtpc.org/mholley/RadioElectronics/Nov1967/RE_Nov1967.htm
Ausführlicher Nachruf auf Hugo Gernsback aus der Radio-Electronics vom November 1967.

https://arstechnica.com/tech-policy/2010/05/ralph-124c-41-a-century-later
Ars Technika Artikel über den Mann, der die Zukunft erfunden hat.

https://news.nationalpost.com/full-comment/scott-van-wynsberghe-the-strange-story-of-hugo-gernsback-who-brought-science-fiction-magazines-to-america
Etwas kritischerer Artikel über die Rolle von Hugo Gernsback.

www.decadecounter.com/readingroom/article20160403.htm
Weiterer ausführlicher Artikel über Hugo Gernsback.

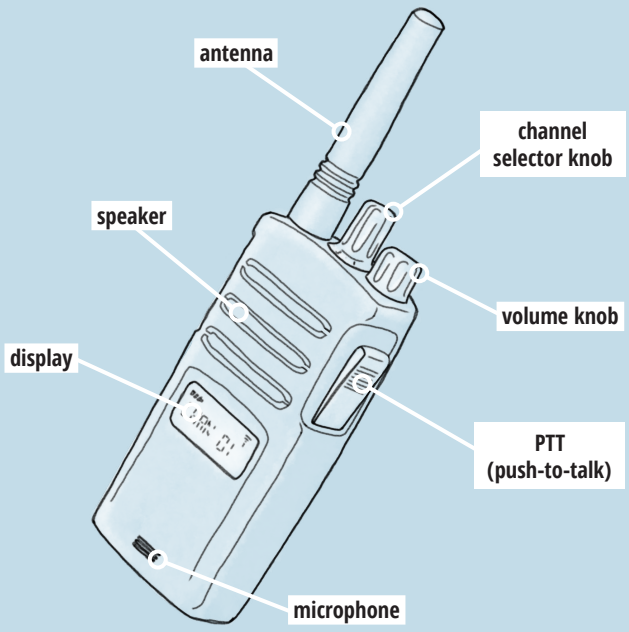
https://archive.org/search.php?query=hugo+gernsback
Im Internet Archive finden sich viele Scans alter Gernsback Magazine.

https://patents.google.com/?inventor=hugo+gernsback&oq=hugo+gernsback
Suchergebnisse zu Gernsbacks Patenten.

www.thehugoawards.org
Webseite der Hugo Awards für Science-Fiction Literatur.

TECH EXTRAS

PICTORIAL
TWO-WAY RADIO (WALKIE-TALKIE)



MINI DICTIONARY
TELECOMMUNICATIONS

amplitude modulation	*Amplitudenmodulation*
audible	*hörbar*
bandwidth	*Bandweite*
beam	*Strahl*
breakout cable	*Kabelpeitsche*
broadcasting	*Rundfunk*
busy tone	*Besetztton*
carrier wave	*Trägerwelle*
channel	*Kanal*
continuous wave	*ungedämpfte Welle*
dedicated line	*Standleitung*
descrambler	*Decodiergerät*
dial pulse	*Wählimpuls*
dipole antenna	*Dipolantenne*
dummy load	*Blindlast*
frequency modulation	*Frequenzmodulation*
handset	*Telefonhörer*
parabolic dish	*Parabolantenne*
phase shift keying	*Phasenumtastung*
push-button dial	*Tastenwahl*
speakerphone	*Freisprecheinrichtung*
transmission speed	*Übertragungsgeschwindigkeit*
up-link	*Sendestrecke*
waveguide	*Hohlleiter*
wavelength	*Wellenlänge*

RADIO TELESCOPE EFFELSBERG

Das Radioteleskop Effelsberg war lange Zeit die größte bewegliche "Schüssel" der Welt. Doch selbst an seinem 50. Jubiläum ist das stählerne Ohr zum Weltall noch lange kein altes Eisen, wovon sich Besucher auf einer Wanderung durch Raum und Zeit überzeugen können.

< PHOTO: NORBERT JUNKES/MPIFR >

It was one of the greatest engineering *feats* of its time and even today, fifty years later, it stands, quite literally, tall among Germany's engineering *marvels*. *Despite* its impressive size – 100 meters in diameter and 109 meters in height – the radio telescope Effelsberg is, however, somewhat hard to *spot*. The fact that one of the largest radio telescopes in the world lies *hidden* between the Eifel mountains isn't due to *modesty* or *secrecy* – it's actually a design feature.

The highly sensitive radio telescope requires *sufficient* shielding against interfering radiation from all kinds of earthly electronics. When, in 1965, the newly *founded* Max Planck Institute for Radio Astronomy was looking for an ideal location, a deep valley near Effelsberg met all the geological, astronomical, technical and political *requirements* – although the last one required a *federal state* border to be slightly moved.

Its 100-meter *dish* was quite a step up from the big fully *steerable* radio telescopes of the time at Jodrell Bank, Parks or Goldstone. The standard design, a *rigid* space-frame structure, wouldn't have been enough to keep the deformation of the dish to a minimum. In a *bold* and revolutionary move, the designers of Effelsberg instead *embraced* the *unavoidable* deformations – but only in such a way that a paraboloid would *deflect* into another paraboloid so that a simple change of focus could compensate.

By 1970 the main construction was complete and on 23 April, 1971, the radio telescope *received* 'first light'. For the next 30 years Effelsberg would be the largest fully steerable radio telescope in the world, only to be *surpassed* in 2000 by the only slightly larger oval dish of the Green Bank telescope. While the *recently* collapsed Arecibo telescope or the Chinese FAST are much larger, they are built in natural *depressions*, which *severely* limits their observation angle.

Even at its *venerable* age the radio telescope Effelsberg is anything but 'old tech' – constant upgrades *ensure* that the telescope remains *state of the art*. Lately it *supported* the landing of the Mars rover *Perseverance* and also *contributed* to the famous first image of a black hole. While this is more or less 'business as usual' for the astronomers, the list of Effelsberg's firsts and major *discoveries* is long – 5.2 kilometres long to be precise.

That's the length of the Time Travel Trail, the latest of four astronomical walks around the radio telescope. The trail, which starts at the small visitor pavilion, not only offers *stunning* close-up views of the radio telescope, 20 information boards along the way also *chronicle* its history and greatest discoveries. If you still feel strong enough after such an *exhausting* trip to the *edge* of the universe, you can take another orbit around the Planetary Trail, the Milky Way Trail or the Galaxy Trail – just make sure you turn off your smartphone.

<<< Matthias Meier >>>

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www.mpifr-bonn.mpg.de/effelsberg/besucher

bold	*kühn, gewagt*
chronicle, to // 'krɒnɪkl	*erzählen, berichten*
contribute, to	*beitragen, mitwirken*
deflect, to	*verlagern, abbiegen*
depression	*Vertiefung, Senke*
despite	*trotz, ungeachtet*
discovery	*Entdeckung, Fund*
dish	*Schüssel, Schale*
edge	*Rand, Kante*
embrace, to	*annehmen, sich z. eigen machen*
ensure, to	*sicherstellen, garantieren*
exhaust, to // ɪg'zɔ:st	*erschöpfen*
feat	*Meisterleistung, Großtat*
federal state	*Bundesland*
found, to	*gründen, etablieren*
hidden	*versteckt, verborgen*
marvel	*Wunder*
modesty	*Bescheidenheit, Zurückhaltung*
perseverance // ˌpɜ:sə'vɪərəns	*Ausdauer, Durchhaltevermögen*
receive, to	*empfangen*
recently	*jüngst, vor Kurzem*
requirement	*Anforderung, Vorgabe*
rigid // 'rɪdʒɪd	*fest, steif*
secrecy // 'si:krəsi	*Geheimhaltung*
severely // sɪ'vɪəli	*erheblich, stark*
spot, to	*entdecken, erspähen*
state of the art	*auf dem Stand der Technik*
steerable	*lenkbar, steuerbar*
stunning	*atemberaubend, überwältigend*
sufficient // sə'fɪʃnt	*genügend, ausreichend*
support, to	*unterstützen, begleiten*
surpass, to // sə'pɑ:s	*übertreffen, übertrumpfen*
unavoidable // ˌʌnə'vɔɪdəbl	*unvermeidbar, unausweichlich*
venerable // 'venərəbl	*altehrwürdig, ehrenwert*

MIXED UP

It's easy to mix up one word with another. Some seem to be the same as words used in German but have completely different meanings. Others are often simply used wrongly. With our help you won't mix things up.

Der erste Vergleich in dieser Saison ging 0:0 aus.

- ☐ The first *match* this season finished 0:0.
- ☐ The first *comparison* this season finished 0:0.
- ☐ The first *contrast* this season finished 0:0.

- ☐ In that *sense* I'll finish off now. Thank you for listening.
- ☐ On that *note* I'll finish off now. Thank you for listening.
- ☐ With that *meaning* I'll finish off now. Thank you for listening.

In diesem Sinne mache ich Schluß für heute. Vielen Dank für Ihre Aufmerksamkeit.

Es gibt eine lange Liste von Bewerbern.

- ☐ There is a long list of *appliances*.
- ☐ There is a long list of *applications*.
- ☐ There is a long list of *applicants*.

- ☐ The *cookies* are all in the tin.
- ☐ The *cakes* are all in the tin.
- ☐ The *cooks* are all in the tin.

Die Kekse sind alle in der Dose.

Wir haben eine Annonce in der örtlichen Zeitung geschaltet.

- ☐ We *changed* an ad in the local newspaper.
- ☐ We *placed* an ad in the local newspaper.
- ☐ We *switched* an ad in the local newspaper.

- ☐ *Freshly painted!*
- ☐ *New paint!*
- ☐ *Wet paint!*

Frisch gestrichen!

//// Answers ////

The first *match* this season finished 0:0.
comparison = Vergleich (aber nicht im sportlichen Sinne) >>> The *comparison* of the two cars showed there was little difference between them.
contrast = Gegensatz, Vergleich >>>
Downtime this year is close to zero, in stark *contrast* to last year.

There is a long list of *applicants*.
appliance = Gerät, Haushaltsgerät >>>
All of the *appliances* are already fully installed.
application = Bewerbung >>>
Applications should be submitted by the end of the month.

We *placed* an ad in the local newspaper.
change, to = u.a. austauschen, ändern >>>
Change the batteries, they are very low.
switch, to = u.a. (ein, aus)schalten >>>
Switch off the lights when you leave the room.

On that *note* I'll finish off now. Thank you for listening.
sense = Sinn (Gefühl) >>>
It is so cold I have no *sense* of feeling in my fingers.
meaning = Bedeutung >>>
The word 'provision' has a lot of different *meanings*.

The *cookies* are all in the tin.
cake = Kuchen >>>
A gateau is a type of cream *cake*.
cook = Koch >>>
Too many *cooks* spoil the broth.

Wet paint!
freshly painted = nicht üblich
new paint = neue Farbe, nicht üblich in diesem Zusammenhang

WORD COMBINATIONS

Some individual words in English are commonly combined with others to provide a variety of concepts. Find words in the boxes below to complete the word combinations which match the definitions.

//// ANSWERS ON PAGE 58 ////

ring	1	A type of folder for filing documents.
ring	2	The sound you hear when someone phones you.
ring	3	One of the digits on a hand.
ring	4	Someone who starts up something illegal.

wedding	binder	tone	outer	drugs	circus	side	leader
holder	diamond	finger	gasket	key	inner	boxing	rubber

A kind of a seal, sometimes shaped like an 'O'.	5	ring
Young children might wear this around their waist in a swimming pool.	6	ring
Also called a fob; keeps all your door-opening tools together.	7	ring
A 'square' where a fight takes place.	8	ring

water	1	A device that makes your drink 'cleaner' or 'purer'.
water	2	Another word for level; below this, the ground is saturated with water.
water	3	You measure this in bar.
water	4	In a river or a stream, this is normally part of a mill.

sea	running	tap	sports	fresh	supply	fizzy	pressure	waste
surface	table	shortage	temperature	wheel	soft	filter		

Brine, there is salt in this stuff, so you shouldn't drink it.	5	water
'Used' water, from the toilet or after a production process.	6	water
After heavy rain, you might find this on the roads.	7	water
A drink that comes from the mains.	8	water

Die Null ist sicher die faszinierendste der zehn Ziffern unseres Dezimalsystems: Sie wurde dreimal erfunden, dient zwei Zwecken und ist doch einzigartig. Die Null wurde vergessen, gefürchtet, verboten und geheim gehalten, bevor sie vor nicht allzu langer Zeit endlich auch in Schulen gelehrt wurde. Doch was genau ist die Null – und was hat Shakespeare mit all dem zu tun?

< PHOTO: BELINDA FEWINGS/UNSPLASH.COM >

DECIPHERING ZERO

Zero is certainly the most fascinating of the ten numerals *of our decimal system: It was* invented *three times, serves two* purposes *and is* unique. *Zero was forgotten, feared, banned and became a secret until it was finally* taught *in schools not too long ago. So, what exactly is zero – and what's Shakespeare got to do with it?*

Shakespeare never knew the number zero. When I came across this *surprising* headline on my *recent* web travels, I was, unfortunately, too busy to follow it up. Then again, it was probably cheap *clickbait* anyway. But somehow the headline got stuck in my head. *Admittedly*, the adoption of the Hindu-Arabic numeral system in Europe happened rather late – but was it really that late? By 1600 the people in England must have certainly *dropped* the *cumbersome* Roman numerals, which didn't have a zero. Or did they? And what is zero anyway?

Despite an intensive search, I never could find the original website with the *outlandish claim* again. Instead, I fell into a *rabbit* hole and entered a wonderland of numbers and *noughts*. So, let's follow the White Rabbit to *decipher* zero and look for some math in Shakespeare's work – because, as King Lear put it, "nothing will come of nothing."

NOTHING IS A PLACE HOLDER

Zero *equals* two as any mathematician will tell you – two different concepts that is. The more ground-breaking of the two is certainly the concept of zero as a number representing nothing, or "an empty set". Let's save the details for later as this is a bit complicated and will *require* the help of an Indian math guru.

Much easier to explain is zero's second use as a placeholder in place-*value* number systems. The simplest of these systems is the binary system on which computers are based *consisting of* just 1 and 0. The most *common* is certainly the decimal system.

In a place-value number system the value a certain *digit* represents depends on its place, whereas the places are exponents of the base. In our decimal system, which has a base of ten, we have places for the "ones", the "tens", the "hundreds" or ten *squared*, the "thousands" or ten *cubed* and so on. 417, for example, is four "hundreds" plus one "ten" plus seven "ones". Place-value number systems are highly efficient for writing down numbers and calculating but they come with a little *caveat*. Every time you reach the base and add one to the next higher place you need something to fill the *current* place which has no value, as in, for example,

100, which has one "hundred", no "tens" and no "ones". Welcome to the zero as a placeholder.

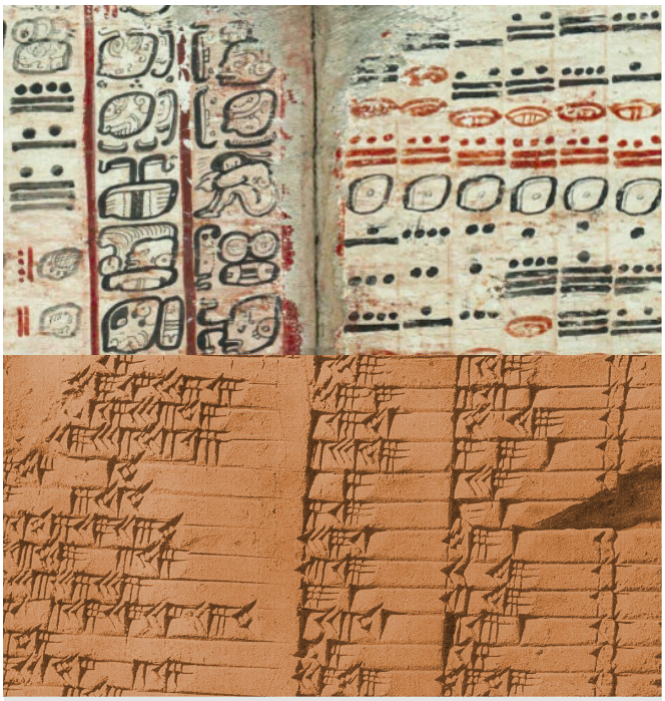
The first to use a place-value number system were the Babylonians some 4,000 years ago. Their *sexagesimal* system had a base of 60 which may sound rather *odd* – but only until you look at your watch. The 60-minute division is a distant *remnant* of this sexagesimal system. The Babylonians were also the first to introduce placeholders symbolized by a small double *wedge* around 300 BC. This wasn't, however, a "*proper*" zero as it was only used in the middle position but never at the end, so you had to *guess* whether the digit for, say, 50 actually meant the number 50 or 3000.

By the fourth century BC the Greeks had *half-heartedly* adopted the Babylonian idea of zero but never really *got the hang of* it. On the one hand, their math was mainly based on geometry and worked perfectly fine without a zero; on the other hand, a symbol for nothing didn't really *agree with* Aristotle's *postulate* that nature *abhors* a vacuum. The Greeks' *neighbours*, the Romans, never seemed to have *bothered* with placeholders as Roman numerals didn't have a zero. After the spread of the Roman Empire the zero slowly *faded* into *oblivion* – at least in Europe.

Some 800 years later the Mayans in Central America *independently* developed the concept of a zero and used it for their number system, which was based on 20. Unfortunately, or luckily, the people in Central America didn't come into contact with Europeans until much later – and when they finally did, teaching math was the *least* of their *worries*.

The concept how we, today, use zero most likely developed in India or South East Asia around the fifth century AD. There are several *contenders* for the first zero *on record*: the Bakshali manuscript from today's Pakistan, a *carving* in a temple in Gwalior, India, or another one in a temple near Angkor Wat in Cambodia. For a symbol representing >>>

abhor, to // əb'hɔ:	*verabscheuen, hassen*
admittedly	*zugegebenermaßen*
agree with, to	*zusammenpassen, einig sein mit*
bother, to	*sich kümmern, sich die Mühe machen*
carving	*hier: Bildhauerarbeit*
caveat // 'kæviæt	*Vorbehalt, Widerspruch*
claim	*Behauptung, Aussage*
clickbait	*Klickköder*
common	*gebräuchlich, üblich*
consist of, to	*bestehen aus*
contender	*Anwärter/in, Mitbewerber/in*
cube, to	*hoch drei nehmen*
cumbersome // 'kʌmbəsəm	*umständlich, sperrig*
current	*aktuell, gegenwärtig, geltend*
decipher, to // dɪ'saɪfə	*entziffern, entschlüsseln*
despite	*trotz, ungeachtet*
digit // 'dɪdʒɪt	*Ziffer*
drop, to	*fallen (lassen), ablegen*
equal, to	*gleichen, gleich sein*
fade, to	*verbleichen, verblassen*
get the hang of, to (got, gotten)	*kapieren, den Dreh raushaben*
guess, to	*raten, erahnen*
half-heartedly	*halbherzig*
independently	*unabhängig*
invent, to	*erfinden, ausdenken*
least	*am wenigsten, kleinste/r/s*
neighbour // 'neɪbə	*Nachbar, Nachbarin*
nought // nɔ:t	*Null*
numeral	*Zahl*
oblivion	*Vergessenheit*
odd	*seltsam, eigenartig*
on record	*offiziell, aktenkundig, registriert*
outlandish	*absonderlich, befremdlich*
postulate	*Voraussetzung, Postulat*
proper	*richtig, korrekt, eigentlich*
purpose // 'pɜ:pəs	*Zweck, Bestimmung*
rabbit	*Kaninchen*
recent // 'ri:snt	*jüngst, neulich, kürzlich*
remnant	*Überbleibsel, Relikt*
require, to	*erfordern, benötigen*
sexagesimal // ˌseksə'dʒəsəməl	*Sechziger-*
square, to	*quadrieren*
surprise, to	*überraschen, erstaunen*
teach, to (taught, taught)	*lehren, unterrichten*
unique // ju'ni:k	*einzigartig*
value	*Wert, Größe*
wedge // wedʒ	*Keil*
worry	*Sorge, Angst*



The Mayans and the Babylonians used zero as a placeholder long before the decimal system emerged in India. The Mayan zero was shaped like a loaf of bread (top), the Babylonian like a small double wedge (below).

nothing *scholars* can get pretty heated up when discussing which of them is the oldest.

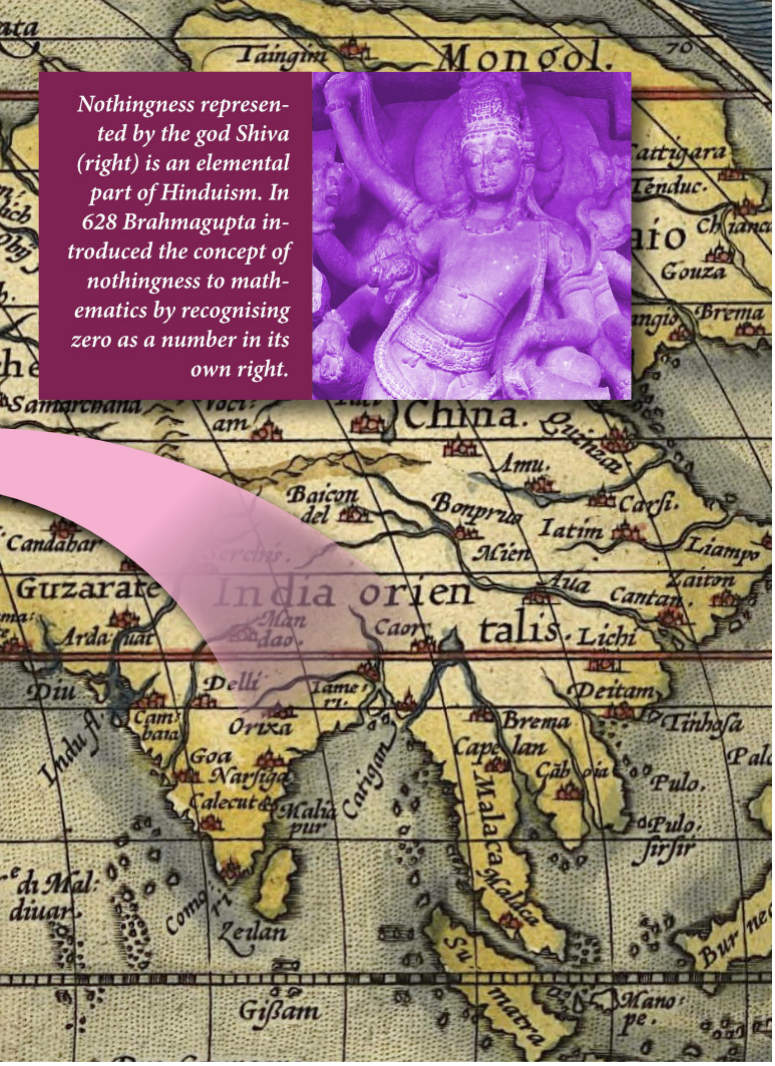
NOTHING NEGATIVE

Quite *undisputed*, however, is the role of the Indian mathematician and astronomer Brahmagupta in the history of zero. In his book Brahmasphutasiddhanta from 628 he not only introduced negative numbers but also *recognised* zero as a number in its own right for the first time. For Brahmagupta zero was simply the number you got when you *subtracted* any number from itself – as easy as that. He never feared the *ensuing* "vacuum" as nothingness is one of the basic principles of Asian philosophy. Consequently, the new number was called "sunya" after Sunyata, the Indian philosophical concept of *emptiness* and its symbol became a circle, which also represents life.

It was quite some life this new concept breathed into math. Now zero was no longer just a placeholder in the Indian decimal system but a number you could do proper math with – for which Brahmagupta also *provided* the rules although he, like many mathematicians after him, *struggled* a bit with the *division* by zero. Zero as a number not only opened up the negative number space and made it easier to work with *fractions* and decimals, but without zero later *developments* such as *calculus*, which *paved the way* for physics, engineering and a lot of financial and economic theory, would have been impossible. Zero is of course also *responsible* for at least half of the digital revolution.

But before zero became an *essential* part of our digital lifestyle it still had a long way to go. Thanks to its *ease of use* the Hindu decimal system including zero soon *spread* throughout the whole of Asia and also reached the Arabic world via the *silk* road. Around 820 the Persian mathematician and *head librarian* of the House of *Wisdom* (see also INCH 07 | 1001 Arabian Devices) in Baghdad Al-Khwarizmi *described* the Hindu numerals in his books and used them to develop new mathematical knowledge – not at least thanks to the zero which he called "sifr" for "empty" in *reminiscence* of the Indian "sunya". His work was in fact so ground-breaking and *influential* that this name, Al-Khwarizmi, would be *immortalised* in the word 'algorithm' and the title of his major work, Al-Jabr, in the word 'algebra'. As a result, his "Arabic" numerals became *henceforth* synonymous with the decimal system.

Unfortunately, this naming scheme was a bit of a problem *regarding* the adoption of the decimal system in Europe. In the *Middle Ages* the *Crusades* were *in full swing* and everything "Arabic" was naturally met with great *mistrust*. *In this regard* 1202 wasn't a great year for publishing a book that *promoted* Hindu-Arabic numerals and the decimal place-value system that came with them. *Nonetheless*, the "Liber Abaci" by Leonardo of Pisa, better known as Fibonacci, who had learned about this new number system during his travels in the Middle East, became somewhat of a best-seller – at least among those who did math on a daily basis and *hence* realised the *superiority* of Arabic over Ro-



Nothingness represented by the god Shiva (right) is an elemental part of Hinduism. In 628 Brahmagupta introduced the concept of nothingness to mathematics by recognising zero as a number in its own right.

man numerals. After all, *book keeping* is so much easier when *revenue* and *expenditure* add up to zero. Their quick adoption by *merchants* and bankers may have been another reason why zero and its *fellow* nine digits were viewed *suspiciously* by the authorities.

The *scepticism* went so far that in 1299 the use of Arabic numerals was banned outright in Florence, *supposedly* because they were easy to *forge* – as if you couldn't just as easily turn a Roman V into an X. The church didn't like the new numerals *either*, especially the zero. When God was in everything that was, *clerics argued*, a symbol for nothing must surely be of the devil. Devil or not, the Hindu-Arabic numerals were just plain useful and so *tradespeople* kept on using them – *albeit* in *secrecy*. The new numerals including the zero, the Arabic "sifr" or "cipher" as it was *pronounced* in Europe, *literally* became a code, a well-kept secret which only the *knowledgeable* could "decipher".

SHAKESPEARE'S STORY OF O

As a consequence, it took centuries for this secret to spread from Italy to the rest of Europe. *Gradually*, the zero lost its horror and more and more people discovered how much easier math was when you added "nothing". Ultimately, Hindu-Arabic numerals were even taught in schools. When in the 1570s a young boy named Will *attended* school in Stratford-upon-Avon, he was among the first generation of school kids in England who learned that "there are but tenne figures that are used in Arithmetick; and of those tenne, one doth signifie >>>

albeit // ˌɔːlˈbiːɪt	*wenn auch, obgleich*
argue, to	*argumentieren, einwenden*
attend, to	*besuchen*
book keeping	*Buchführung*
calculus // ˈkælkjələs	*Infinitesimalrechnung, Differential- und Integralrechnung*
cleric	*Geistlicher, Geistliche*
Crusade // kruːˈseɪd	*Kreuzzug*
describe, to	*beschreiben, darstellen*
development	*Entwicklung*
division	*Teilung*
ease of use	*Benutzerfreundlichkeit, einfache Nutzung*
either // ˈaɪðə	*hier: auch*
emptiness	*Leere, Nichts*
ensue, to // ɪnˈsjuː	*sich ergeben, folgen*
essential	*wesentlich, grundlegend*
expenditure // ɪkˈspendɪtʃə	*Ausgaben*
fellow	*Mit-, Kollege, Kollegin*
forge, to // fɔːdʒ	*fälschen*
fraction	*Bruch (-zahl)*
gradually	*allmählich, nach und nach*
head librarian // hed laɪˈbreəriən	*Bibliotheksdirektor*
hence // hens	*daher, deshalb*
henceforth // ˌhensˈfɔːθ	*fortan, von nun an*
immortalise, to	*verewigen, unsterblich machen*
in full swing	*in vollem Gang*
in this regard	*in dieser Hinsicht*
influential // ˌɪnfluˈenʃl	*einflussreich, maßgebend*
knowledgeable	*wissend, kundig, gelehrt*
literally	*buchstäblich, wörtlich*
merchant // ˈmɜːtʃənt	*Kaufmann, Kauffrau, Händler/in*
Middle Ages	*Mittelalter*
mistrust	*Misstrauen, Argwohn*
nonetheless	*nichtsdestotrotz, dennoch*
pave the way, to	*den Weg ebnen*
promote, to	*bewerben, voranbringen*
pronounce, to	*aussprechen*
provide, to	*bieten, liefern*
recognise, to	*erkennen, wahrnehmen*
regarding	*in Bezug auf, hinsichtlich*
reminiscence // ˌremɪˈnɪsns	*Erinnerung, Anklang*
responsible	*verantwortlich*
revenue // ˈrevənjuː	*Einnahmen*
scepticism // ˈskeptɪsɪzəm	*Skepsis*
scholar // ˈskɒlə	*Gelehrte/r, Wissenschaftler/in*
secrecy	*Verborgenheit, Geheimhaltung*
silk	*Seide*
spread, to	*verbreiten, verteilen*
struggle, to // ˈstrʌgl	*ringen, kämpfen*
subtract, to	*abziehen, subtrahieren*
superiority // suːˌpɪəriˈɒrəti	*Überlegenheit*
supposedly	*angeblich, vermeintlich*
suspiciously	*verdächtig, misstrauisch*
tradespeople	*Händler, Händlerinnen*
undisputed	*unbestritten, unangefochten*
wisdom	*Weisheit*

< GRAPHIC: GREGOR REISCH >

The abacist versus the algorist: In Europe it took centuries before calculating with an abacus was finally replaced by the decimal system and Hindu-Arabic numerals (below).

Hindu numerals (Gwalior 9th century)

Arabic numerals

1 2 3 4 5 6 7 8 9 0

A NUMBER BY ANY OTHER NAME

Number: A number is a *quantity*. It always has the same *value*, no matter what word or symbol is used.

***Numeral*:** A numeral is a symbol or word representing a number, e.g. twenty-three, dreiundzwanzig, vingt-trois, 23, XXIII.

***Digit*:** A digit is a symbol used either alone or in combination with other digits to make up a numeral, e.g. 0,1,2,3,4,5,6,7,8 and 9 are the digits used in the decimal system.

***Figure*:** The word figure is *interchangeably* used to *refer to* digits as well as numerals, e.g.: "The boat *performed* a figure-of-eight manoeuvre" or "My boss is *earning* big figures".

nothing, which is made like an O, and is privately called a Cypher." That's how Robert Recorde introduced young, *impressionable minds* to the zero in his book "Arithmetic or the Ground of Arts" from 1543, which was one of the first printed English *textbooks* on arithmetic and the most popular of its time.

It was quite an *impression* that this O, this cipher, left on young Shakespeare. Not only did he know the number zero *by heart*, he even wrote about it several times. In the Winter's *Tale*, act 1, scene 2, Polixenes says:

> Go hence in *debt*: and therefore, like a cipher,
> Yet standing in rich place, I multiply
> With one 'We thank you' many thousands moe
> That go before it.

Another cipher or zero appears in the first act's prologue of Henry V:

> O, pardon! since a *crooked* figure may
> *Attest* in little place a million;
> And let us, ciphers to this *great accompt*,
> On your imaginary forces work.

accounting	*Buchhaltung, Rechnungswesen*
accounting ledger // ə'kaʊntɪŋ 'ledʒə	*Hauptbuch (Buchführung)*
additional	*zusätzlich, nachträglich*
attest, to	*belegen, bestätigen*
bard	*Barde, Dichter/in*
by heart	*auswendig*
console, to	*trösten, vertrösten*
crooked	*schief, krumm, gebogen*
debt // det	*Schulden, Verpflichtung*
digit // 'dɪdʒɪt	*Ziffer*
earn, to	*verdienen*
figure	*hier: Zahl, Ziffer*
fool	*Narr*
great accompt	*hier: Hauptbuch (Buchführung)*
hidden	*verborgen, versteckt*
impression	*Eindruck, Wirkung*
impressionable	*beeinflussbar, leicht zu beeindrucken*
indeed	*tatsächlich, in der Tat*
indefinite // ɪn'defɪnət	*unbestimmt*
interchangeably // ˌɪntə'tʃeɪndʒəbli	*austauschbar, synonym*
jester // 'dʒestə	*Hofnarr, Spaßmacher*
mind	*Geist, Verstand*
nada	*hier: Null, Nichts*
numeral	*Zahl*
perform, to	*ausführen, vollführen*
quantity	*Menge, Betrag*
refer to, to // rɪ'fɜ:	*sich beziehen, hinweisen*
reference, to	*verweisen, Bezug nehmen*
tale	*Geschichte, Märchen*
textbook	*Lehrbuch, Schulbuch*
value	*Wert, Größe*
zilch // zɪltʃ	*hier: Null, Nichts*
zip	*hier: Null, Nichts*

Interestingly, both examples also *reference* bookkeeping with words such as "debt" or "great accompt", i.e. an *accounting ledger*, which proves how important the zero had become for *accounting*.

The *bard's* most famous but also most *hidden* reference to zero, however, can be found in King Lear, act 1, scene 4, when the *Fool* tells the King: "Now thou art an O without a figure … thou art nothing." Although the *indefinite* article clearly identifies O as a letter it's actually the numeral because zero "is made like an O" as young Will had learned in school. And a zero without any *additional* figures, or digits, is *indeed* nothing. Poor King Lear, to be told by his own *jester* that he is zero, *zip*, *zilch*, *nada*. Maybe he should *console* himself with the fact that this O, this sunya, sifr, cipher, zero, or whatever you call it, is certainly the most important nothing in the world. *<<< Matthias Meier >>>*

www.washingtonpost.com/archive/2000/01/12/the-history-of-zero/36a6a2fd-9e18-484d-ae6f-450af0340830
www.livescience.com/27853-who-invented-zero.html
https://mathshistory.st-andrews.ac.uk/HistTopics/Zero
www.cantorsparadise.com/the-invention-of-zero-6a5b4a8e5b15
https://mt.mediatinker.com/blog/archives/008821.html
Eine eher zufällige Auswahl weiterer Artikel über die Geschichte der Null.

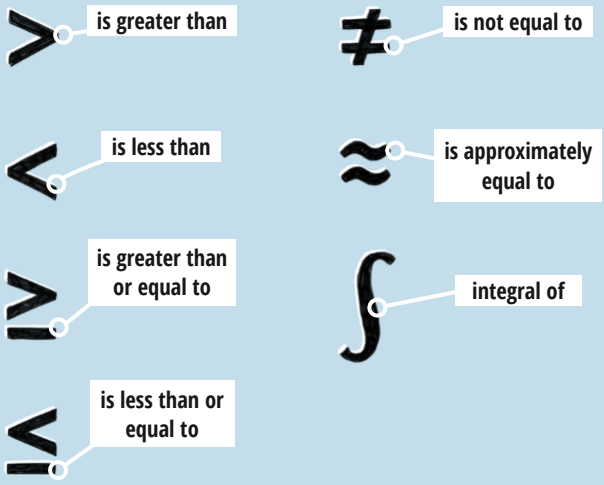
www.salon.com/2013/08/04/shakespeare_defined_our_concept_of_nothingness
Ausführlicher Artikel über die Rolle des Nichts und der Null in Shakespeares Werk.

www.vox.com/science-and-health/2018/7/5/17500782/zero-number-math-explained
Ein Artikel, der sich mit unserem kognitiven Verständnis der Null befasst.

Links, Vokabeln & mehr unter
www.inchbyinch.de/inch35/zero

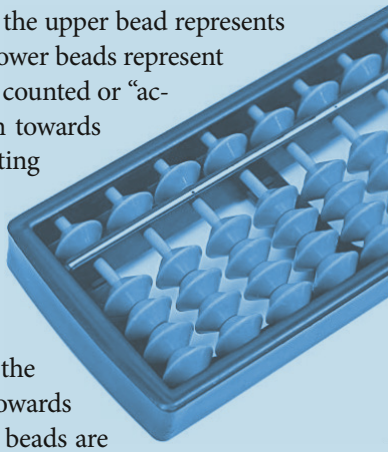
TECH EXTRAS

PICTORIAL **MATHEMATICAL SYMBOLS**



HOW **AN ABACUS** WORKS

The abacus is an *ancient* calculating tool which *consists of* a *frame* with several *rods* holding movable *beads*. The Russian or European abacus has horizontal rods with ten beads each, while the Asian abacus, or suanpan, has vertical rods and a middle-*beam* separating the upper one or two beads from the lower four or five beads.



In such a 4+1 abacus the upper bead represents a *value* of five while the lower beads represent a value of one. Beads are counted or "activated" by moving them towards the middle beam. Counting from one to ten starts with moving the lower beads towards the middle. When reaching five, the lower beads are *slid* down and the upper bead is moved towards the centre. At ten all the beads are moved away from the middle beam and one bead is "added" on the rod to the left.

While basic operations like addition and subtraction are relatively *straightforward* more *advanced* math like multiplications, divisions or *square roots require* more complicated methods which can vary between different countries.

advanced	*fortgeschritten*
ancient // 'eɪnʃənt	*alt, antik*
bead // bi:d	*Perle, Kügelchen*
beam	*Balken, Stange*
consist of, to	*bestehen aus*
frame	*Rahmen*

require, to	*brauchen, verlangen*
rod	*Stab, Stange*
slide, to (slid, slid)	*schieben, gleiten*
square root	*Quadratwurzel*
straightforward	*unkompliziert, einfach*
value // 'vælju:	*Wert, Größe*

DECIDE

>>> A TALE OF TWO ROCKETS // 14

Read the following sentences and decide whether there should be a **comma before the 'which'** marked in **bold**.

1 The first microscopes **which** combined an objective lens near the specimen with an eyepiece were built in the Netherlands.
2 By the beginning of the 20th century the standard for things like windscreens and shop windows was tempered glass **which** is several times stronger than normal glass.
3 The X-59's long, narrow nose is designed to spread out supersonic shockwaves **which** helps to reduce the sound heard on the ground.
4 One of the largest problems has always been the thunder-like sonic boom **which** results from the displacement of air at high pressures around a plane **which** is traveling faster than the speed of sound.
5 Recycling would produce nowhere near the 40 to 50 billion metric tons of sand **which** is used every year in the world.
6 Some of the sand **which** is used for building purposes is not really suitable.
7 Now, we're seeing the likes of Hurricane Dorian **which** destroyed neighbourhoods in the Bahamas in 2019.
8 Smooth nails are not as strong as ring shank nails **which** have threads around the shank to grasp the wood.
9 The strong winds **which** we create in the test centre allow us to probe for weaknesses in construction and design.
10 Between very dry sand and saturated sand there is a wide range of moisture levels **which** are good for building sandcastles.
11 The Space Launch System has a core stage, boosters and four engines **which** are derived from the Shuttle program.
12 On top of the booster sits the Starship upper stage **which** adds another 50 meters to the stack to make it the largest rocket ever built.

//// ANSWERS ON PAGE 58 ////

MATCH

>>> STARS & SPHERES // 6

Match a word from the right column with its correct definition from the left column.

1		very complicated or detailed	A		device
2		a machine or device that appears strange or complicated	B		marvel
3		to imagine a future possibility	C		diver
4		a thing made or adapted for a particular purpose	D		novelty
5		to appear or become visible	E		envision
6		cannot be differentiated from something which is similar	F		delay
7		the person who establishes an organisation	G		intricate
8		a person who swims underwater using special equipment	H		queue
9		something which is new, unusual or original	I		indistinguishable
10		to slow the process of something	J		emerge
11		a wonder, miracle	K		contraption
12		a line of people or vehicles waiting to proceed	L		founder

ReVERB

It is always good to keep revising the English verb forms. Here we practise a variety of tenses in context.

First of all, choose the correct answer from the three options (only one is correct). Then match the simplified explanations of the correct verb forms with the examples in the text. Some explanations might match several examples.

Dogtooth Technologies is a UK technology start-up which (1) _____ (is selling/sells/sold) smart robots for *harvesting* soft fruits. The company (2) _____ (was *founded*/has been founded/is founded) in 2014 and *is based in* Cambridge. Dogtooth (3) _____ (is working/has been working/worked) closely with growers in the area since 2016 to *develop* commercial robotic fruit picking solutions. The number of *migrant workers* necessary to harvest fruit (4) _____ (had already fallen/already fell/has already fallen) *significantly* before the UK officially (5) _____ (has left/was leaving/left) the EU at the end of 2020 and the need for robotic harvesting (6) _____ (grew/is growing/has been growing) dramatically since then. Last year Dogtooth (7) _____ (has/had/has had) over 70 robots picking 5 hectares of strawberries and the manufacturing capacity (8) _____ (is rising/rises/rose) constantly. Until recently the robotic system (9) _____ (has not been/is not/was not) as cost effective as using humans but that has now changed. This is mainly *due to* the possibility of working longer shifts both during the day and at night. On top of this, the company (10) _____ (has introduced/has been introducing/was introducing) a patented quality control *monitoring* system which is far more efficient than any human is capable of. An updated version of this system (11) _____ (will be *launched*/launches/launched) within the next 6 months. Dogtooth (12) _____ (has now worked/is now working/now works) with customers internationally to expand the service.

//// ANSWERS ON PAGE 59 ////

A _____ something that happened at a specific time in the past

B _____ an action that started in the past and is still going on

C _____ some process happening at present

D _____ something that happened before another point in the past

E _____ happened at a specific point in the past (passive)

F _____ a company's general activity

G _____ a future event (passive)

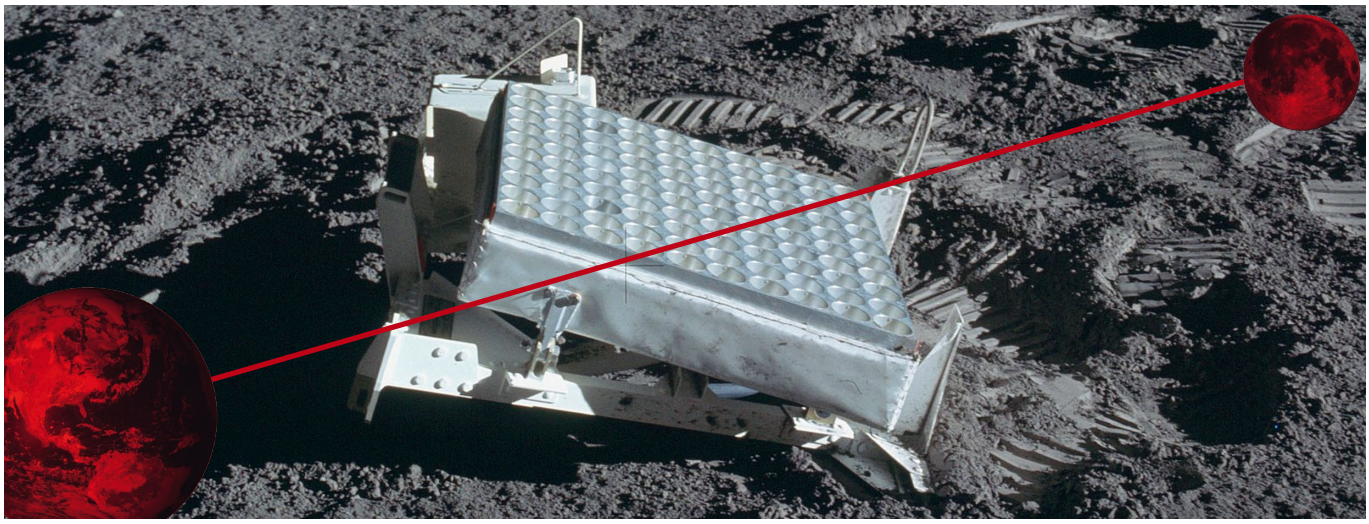
H _____ an action that is over, but there is no specific time given

develop, to	*entwickeln*
due to // 'dju:	*wegen*
found, to	*gründen*
harvest, to	*ernten*
is based in	*mit Sitz in*
launch, to // lɔ:ntʃ	*auf den Markt kommen*
migrant worker // 'maɪgrənt 'wɜ:kə	*Wanderarbeiter/in*
monitoring	*Überwachung*
significantly // sɪg'nɪfɪkəntli	*erheblich*

HOW FAR THE MOON

LISTEN IN

Die Apollo 11 Astronauten haben nicht nur Fußabdrücke auf dem Mond hinterlassen, sondern unter anderem auch einen Laserreflektor mit dem bis zum heutigen Tag die Entfernung des Mondes auf Zentimeter genau bestimmt werden kann. Das Ergebnis: In den letzten 50 Jahren hat sich der Mond zwei Meter weiter von der Erde entfernt.



typical
**see list*

The Moon rides an *average* distance of thirty Earth *diameters* away from us. It has a quarter of our diameter, a 50th of our volume, and only an 80th of our mass. Earth, with its *iron core*, is *denser* than the Moon; but it also reflects more light.

**see list ... centre ... *sl*

Yet the moon still *exerts* its *influence* upon us in many ways. While it's a universal metaphor for peace and *tranquillity*, it also *churns* our oceans – pulling two *high tides* and two *low tides* in just a bit more than one day. With each *tidal* change, a tiny bit of Earth's rotational energy is *chewed* up and *dissipated*; and we slow down. Each day is now a twelfth of a second longer than it was when the Egyptians built the Pyramids.

Nevertheless ... exercises ... effect

Earth's tidal influence on the Moon was much greater than hers on us. Our influence on anything movable on the Moon's *surface* slowed her rotation down to the point at which she can no longer rotate relative to us. That's why we only see one side of her.

exterior

calmness
stirs up ... flow
ebb
**see list*
eaten
dissolved

But the *rotational inertia* that we share with the Moon has to stay the same even though Earth *spins* more slowly. So we remember the *ice skater stretching* her arms outward or pulling them in. To have the same inertia when she spins slowly, her arms

**see list*

rotates
**see list ... extending*

alter, to	*ändern, verwandeln*
average	*Durchschnitt, Mittelwert*
beam	*Strahl*
billion	*Milliarde*
bounce, to	*abprallen, aufprallen lassen*
celestial	*Himmel-, himmlisch*
chew, to	*zerkauen*
churn, to	*aufwühlen, heftig bewegen*
core	*Kern*
denser	*dichter*
diameter	*Durchmesser*
dissipate, to	*verbrauchen, auflösen*
exert, to	*ausüben, zur Geltung bringen*
force	*Kraft*
gravity	*Schwerkraft, Gravitation*
haunt, to	*heimsuchen, verfolgen*
high tide	*Flut*
ice skater	*Schlittschuhläufer(in), Eisläufer*
influence	*Einfluss, Einwirkung*
iron	*Eisen*
low tide	*Ebbe*
pace	*Tempo, Takt, Geschwindigkeit*
rotational inertia	*Massenträgheitsmoment*
scheme	*Plan, System, Schema*
season	*Jahreszeit*
shape	*Form, Gestalt*
silken	*seiden, seidig*
species	*Art, Gattung, Spezies*
sphere	*Kugel*
spin, to	*drehen, kreiseln*
squat	*gedrungen, stämmig*
stately	*prächtig, majestätisch*
stretch, to	*strecken, ausbreiten*
surface	*Oberfläche*
thread	*Faden, Strang*
tidal	*Gezeiten-, Flut-*
tranquillity	*Ruhe, Gelassenheit*
yet	*dennoch, trotzdem*

have to be further outstretched. Likewise, as we slow, the Moon (our outstretched arm) moves away; and our combined rotational inertia stays unchanged.

And we can now measure the movement: When astronauts walked on the moon in 1969, they did a small but important thing – largely forgotten today. They installed a special 18-inch reflector. Now we can *bounce* laser *beams* from Earth off it. Since we know almost exactly how fast light travels, we can measure the distance to the moon within an inch. We now know that the Moon drifts away from us at the rate of an inch and a half per year.

reflect ... rays

None of this will mean much in our lifetimes, of course. But in the larger *scheme* of things it's important. Long ago, a day lasted only twelve hours with the moon only half as far away. And the speed of rotation has influenced Earth's *shape*:

plan

form

Earth's equatorial diameter is about 26 miles greater than her polar diameter. She's just a bit *squat* in shape – not a perfect *sphere*. That's because the *force* of *gravity* can't quite overcome centrifugal forces. Still gravity does keep us from spreading out like a big spinning pizza. Long ago, when Earth spun more rapidly, it was even less spherical than it is today.

stubby

*ball...power...*see list*

So our *celestial* companion, the Moon, moves through the night sky, *haunting* our dreams. She influences us constantly and methodically. Far into the future, after our *species* is gone, Earth and Moon will continue their *stately* spin across the dance floor of the Heavens – an old couple, their *seasons altered*, their *pace* slowed – but linked by the same *silken threads* of gravity and inertia that have bound them for the last four *billion* years. *<<< John Lienhard >>>*

heavenly

disturbing

kind

majestic

see list

changed ... speed

see list ... strings

10^9

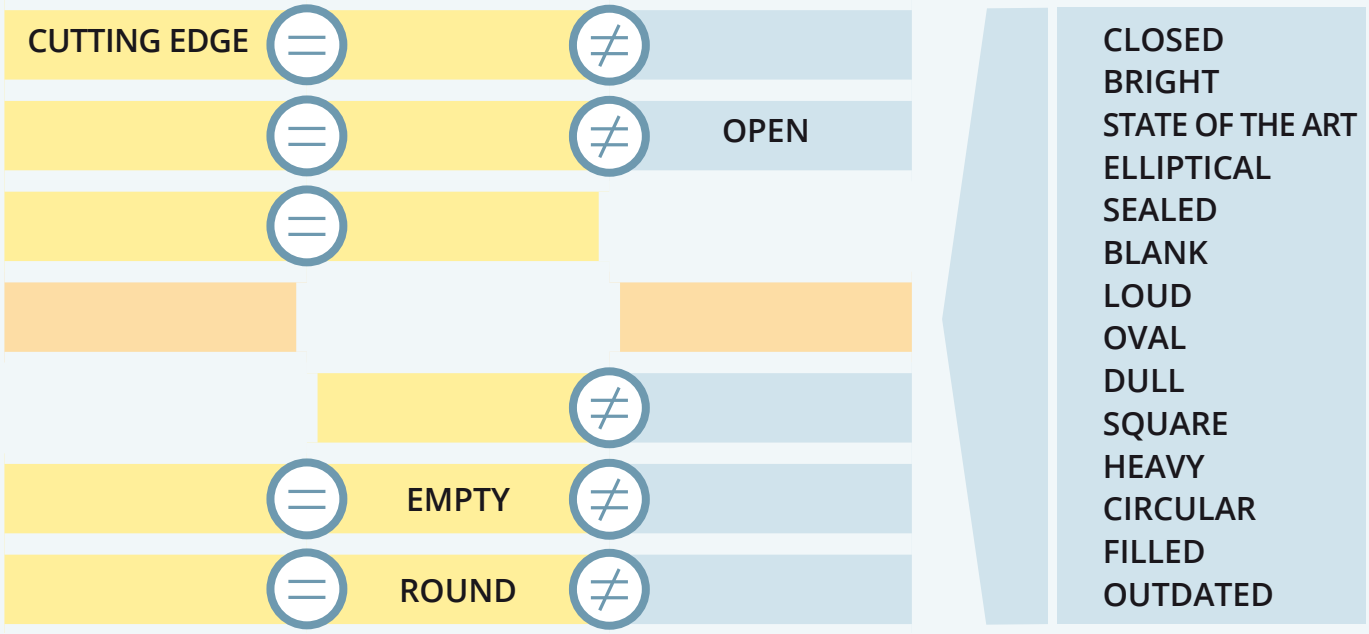
Dieser Text ist Teil der Radioserie „Engines of Our Ingenuity". Er wird mit freundlicher Genehmigung des Autors und der Radiostation KUHF wiedergegeben. Weitere Artikel unter **www.uh.edu/engines**

Audiodatei unter
www.kuhf.org/programaudio/engines/eng2195_64k.mp3

TONGUE & GROOVE

Fill in the boxes using the words on the right of the page. This will give you examples of synonyms and opposites. The two orange boxes are 'leftover' words; there are no synonyms or opposites for these words in the box.

//// ANSWERS ON PAGE 58 ////



THE MANUAL

Use the words next to the pictures to fill in the gaps in the manual instructions.

//// ANSWERS ON PAGE 59 ////

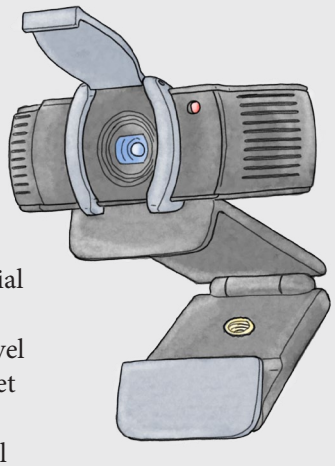
WEBCAM

Video Conferencing Set-up

Video conferencing has become more important than ever. The proper set-up of a webcam is therefore _____. Try to position your webcam at _____ or slightly above so that you don't appear to look down on the other video callers. If you are using a laptop with an integrated camera, raise it from your desktop by positioning it on a box or a _____ of books.

Check your lighting. Strong backlight from a window will make you appear dark and hard to see. If you can't avoid it, dampen the light with some _____. Ideally, position yourself with the window or the main light source diagonally in front of you. When you have to use _____ lighting you don't need a professional set-up with key light, fill light and back light. Sometimes a desk lamp or a simple rice paper _____ can make all the difference.

Good sound is even more important than video quality or perfect lighting. To prevent a 'roomy' or echoing _____ try an external microphone which you can position close to your mouth or use your smartphone's _____.

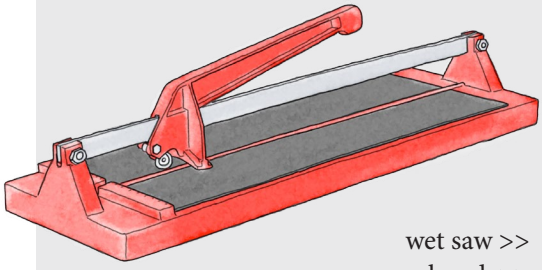


<< artificial
<< shade
<< eye level
<< headset
<< pile
<< crucial
<< sound
<< blinds

Hinweis: Unsere Anleitungen sind lediglich als Sprachübung gedacht. Bitte entnehmen Sie Sicherheits- und Bedienungshinweise der Original-Bedienungsanleitung Ihres Geräts.

SNAP TILE CUTTER

Cutting Tiles



wet saw >>
glazed >>
apply >>
scorer >>
slice >>
pattern >>
snap tile cutters >>
rail >>

_____ are used for straight cuts on ceramic and porcelain tiles. Tiles made from natural stone are cut with a _____ instead. Make sure your snap tile cutter is larger than the tiles you are planning to cut – especially when laying a diagonal _____. Mark up the tile and insert it with the _____ side up into the machine. Make sure the measurement line you drew is positioned directly over the central guide line, which is the thin metallic _____ that runs the length of the cutting surface.

Then lower the handle to bring the _____ into contact with the tile and, depending on the cutter, either push or pull to score once along the line so that the carbide or tungsten-steel blade can _____ through the glazed surface. Avoid multiple passes which may produce uneven cuts or break the tile. Finally, lower the handle fully so that the snapper touches the tile and _____ pressure to snap it in two.

apply, to // ə'plaɪ	*anbringen*
artificial // ˌɑ:tɪ'fɪʃl	*künstlich*
blind // blaɪnd	*Jalousie*
crucial // 'kru:ʃl	*äußerst wichtig*
eye level	*Augenhöhe*
glazed // gleɪzd	*glasiert, glasig*
headset	*Sprechgarnitur, Kopfhörer*
pattern // 'pætn	*Muster*
pile // paɪl	*Stapel*
rail	*Schiene*
scorer	*Schneid- und Rillvorrichtung*
shade	*Lampenschirm*
slice, to	*schneiden*
snap tile cutter	*Fliesenschneider*
sound	*Ton*
wet saw	*Nassschnittsäge*

PINBOARD

Fly Rocket Fly – mit Macheten zu den Sternen
Dokumentarfilm von Oliver Schwehm
Streamingdienste, DVD und Blu-ray

SPACE-D

Aktuell ist viel von privaten Raufahrtunternehmen wie SpaceX die Rede, die es jüngst sogar geschafft haben, erfolgreich Menschen ins All zu befördern. Dabei ist die Idee eines privaten Raumfahrtunternehmens mit großen Ambitionen viel älter als SpaceX. In den 1970er Jahren hat das deutsche Unternehmen OTRAG versucht, mit der Entwicklung einfacher und günstig herzustellender Raketen die Raumfahrtindustrie umzukrempeln.

Der Dokumentarfilm „Fly Rocket Fly – mit Macheten zu den Sternen" dokumentiert die abenteuerliche Geschichte von Lutz Kayser und seiner OTRAG, die von Stuttgart ins tiefste Afrika führt, wo Diktator Mobutu eine 100.000 Quadratkilometer große Fläche als Testgelände zur Verfügung gestellt hat. Ein fast unbekanntes Stück deutscher Raumfahrtgeschichte, das selbst die härtesten Weltraumfans zuweilen fassungslos staunen lässt.

Ada und die
Zahlen-Knack-Maschine
Rachel Katstaller, Zoë Tucker
Nord Süd Verlag
ISBN 978-3-314-10472-5

ADA DIE ZAHLENKNACKERIN

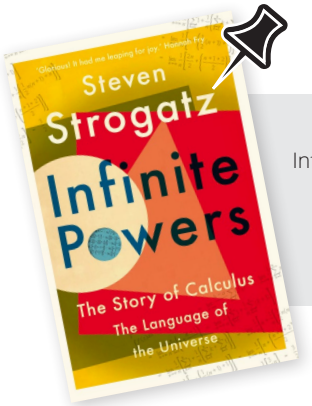
Ada Lovelace ist sicher die Vorzeige-Heldin, wenn es darum geht, kleine Mädchen für naturwissenschaftliche Themen zu interessieren. Aus einer unglücklichen Liaison ihrer Mutter mit dem skandalumwitterten Dichter Lord Byron hervorgegangen, war Ada die Beschäftigung mit literarischen Künsten streng untersagt, so dass sie ihre Kreativität in der Mathematik und Naturwissenschaft ausleben musste. Später hat sie während ihrer Zusammenarbeit mit Charles Babbage die Grundalgen der Programmierung von Computern gelegt – obwohl diese noch gar nicht erfunden waren.

Das liebevoll bebilderte Kinderbuch bringt Kindern ab 5 Jahren das Leben von Ada Lovelace und die Anfänge der Computer nahe und inspiriert gleichzeitig die Kleinsten an sich und ihr Fähigkeiten zu glauben.

DIE MACHT DES UNENDLICHEN

Infinitesimalrechnung mag ja ein mächtiges mathematisches Werkzeug sein, aber Stoff für ein packendes Sachbuch? Der Autor und Mathematiker Steven Strongatz schafft es mit seinem Buch Infinite Powers aus trockener Mathe einen lebendigen Stoff zu machen. Fast ohne Formeln, dafür mit vielen Grafiken, erklärt er die grundlegenden Konzepte des Calculus, wie die Infinitesimalrechnung auf Englisch heißt, und zeigt anhand von vielen Beispielen, wie sie in unserem Alltag zum Einsatz kommt.

Natürlich kommen auch Wissenschaftler und Mathematiker zu Wort, die die Grundlagen der Infinitesimalrechnung geschaffen oder viel damit gearbeite haben. Für den Physiker Richard Feynman war Infinitesimalrechnung sogar „die Sprache Gottes." Ein Buch nicht nur für all jene, die täglich mit Infinitesimalrechnung zu tun haben, sondern auch und besonders für die, die nie mehr etwas davon hören wollten.



Infinite Powers: The Story of Calculus
Steven Strogatz
Atlantic Books
978-1786492951

WEB LINKS

www.youtube.com/user/atlasobscura
Atlas Obscura zählt sicher zu den Lieblingseiten aller, die gern unterwegs sind und Spaß an skurrilen Dingen und Plätzen haben. Was als Blog über schräge Orte und Sehenswürdigkeiten begann, umfasst heute über 15.000 Einträge und ist zu einem Unternehmen gewachsen, das Bücher, Kalender, Veranstaltunge und den hier vorgestellten Youtube-Kanal herausbringt. Herrlich schräg-inspirierende Ablenkung für zwischendurch.

http://technovelgy.com
Wie jeder Trekkie und Science Fiction-Fan weiß, haben SF-Bücher und Filme schon immer die technische Entwicklung inspiriert: Wir alle reden heute wie Captain Picard von der Enterprise mit dem Computer und die Klapp-Kommunikatoren seines Vorgängers sind sogar schon wieder out. Technovelgy.com listet nun über 3.200 dieser Ideen, Konzepte, Erfindungen und Erstermähnungen aus der SF-Literatur auf. Eine prima Inspiration für Erfinder und ein guter Maßstab, wie weit wir schon sind.

https://simple.wikipedia.org
Dass es Wikipedia in dutzenden verschiedenen Sprachen gibt (aktuell sind es 309), wissen wohl die meisten. Unbekannter ist die Tatsache, dass in dieser langen Sprachliste auch Einträge in Simple English gibt, also Englisch mit einfachen Wörtern und Grammatik. Aktuell 163.489 Artikel bieten einen leichten Einstieg ins Englisch.

ANSWERS

FEATURE REVIEW >> SPACE RACE

1. NO comma
2. , which
3. , which
4. NO comma / NO comma
5. NO comma
6. NO comma
7. , which
8. , which
9. NO comma
10. NO comma
11. NO comma
12. , which

FEATURE REVIEW >> STARS & SPHERES

1. g
2. k
3. e
4. a
5. j
6. i
7. l
8. c
9. d
10. f
11. b
12. h

WORD COMBINATIONS

A	**B**
1. ring binder	1. water filter
2. ring tone	2. water table
3. ring finger	3. water pressure
4. ring leader	4. water wheel
5. gasket ring	5. sea water
6. rubber ring	6. waste water
7. key ring	7. surface water
8. boxing ring	8. tap water

TONGUE & GROOVE

cutting edge	=	state of the art	≠	outdated
sealed	=	closed	≠	open
oval	=	elliptical		loud
heavy		dull	≠	bright
blank	=	empty	≠	filled
circular	=	round	≠	square

CROSSWORD

1. emp**L**oy
2. reta**I**ler
3. mar**G**in
4. nic**H**e
5. dep**T**h
6. be**N**eath
7. repl**I**ca
8. expe**N**sive
9. pay**G**rade
10. **P**roof
11. fe**R**ry
12. impr**O**ve
13. dura**T**ion
14. maid**E**n
15. s**C**uba
16. advan**T**age
17. mo**I**st
18. g**O**al
19. lau**N**ch
20. gli**D**er
21. for**E**cast
22. exca**V**ator
23. a**I**sle
24. condu**C**tive
25. yi**E**ld

THE MANUAL

WEBCAM // Video Conferencing Set-up

Video conferencing has become more important than ever. The proper set-up of a webcam is therefore **crucial**. Try to position your webcam at **eye level** or slightly above so that you don't appear to look down on the other video callers. If you are using a laptop with an integrated camera, raise it from your desktop by positioning it on a box or a **pile** of books.

Check your lighting. Strong backlight from a window will make you appear dark and hard to see. If you can't avoid it, dampen the light with some **blinds**. Ideally, position yourself with the window or the main light source diagonally in front of you. When you have to use **artificial** lighting you don't need a professional set-up with key light, fill light and back light. Sometimes a desk lamp or a simple rice paper **shade** can make all the difference.

Good sound is even more important than video quality or perfect lighting. To prevent a 'roomy' or echoing **sound** try an external microphone which you can position close to your mouth or use your smartphone's **headset**.

SNAP TILE CUTTER // Cutting Tiles

Snap tile cutters are used for straight cuts on ceramic and porcelain tiles. Tiles made from natural stone are cut with a **wet saw** instead. Make sure your snap tile cutter is larger than the tiles you are planning to cut – especially when laying a diagonal **pattern**. Mark up the tile and insert it with the **glazed** side up into the machine. Make sure the measurement line you drew is positioned directly over the central guide line, which is the thin metallic **rail** that runs the length of the cutting surface.

Then lower the handle to bring the **scorer** into contact with the tile and, depending on the cutter, either push or pull to score once along the line so that the carbide or tungsten-steel blade can **slice** through the glazed surface. Avoid multiple passes which may produce uneven cuts or break the tile. Finally, lower the handle fully so that the snapper touches the tile and **apply** pressure to snap it in two.

DRAWING BOARD

10	5
18	8
6	2
14	23
21	7
1	12
17	15
20	9
13	4
3	11
22	16
19	

FLOW CHAT

I meet up
E any thoughts as to when
F have time
L tied up
C fine by me
J who needs to be there
D drawing up
H where's the best place to meet
K no preference, really
G we would then have
A is unavailable
B re-arrange my appointments

REVERB

1. sells
2. was founded
3. has been working
4. had already fallen
5. left
6. has been growing
7. had
8. is rising
9. was not
10. has introduced
11. will be launched
12. is now working

a. 2 / 5 / 7 / 9
b. 3 / 6
c. 8 / 12
d. 4
e. 2
f. 1
g. 11
h. 10

TEAM

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IMPRESSUM

Inch TECHNICAL ENGLISH INCH BY INCH

Inch | Technical English – Inch by Inch ist das Sprachlernmagazin für technisches Englisch. Gestaltet von einem erfahrenen Team von Redakteuren und Sprachtrainern vermittelt es Fachenglisch für technische Berufe durch spannende und unterhaltsame Technikreportagen. Zur Leseerleichterung werden schwierige Vokabeln und Fachwörter markiert und in einer Vokabeltabelle übersetzt. Hinzu kommen Fachwörter,Technikgrundlagen, Geschäftswissen und Vokabel- und Grammatikübungen, die auf den Berufsalltag von Ingenieuren und Technikern zugeschnitten sind.

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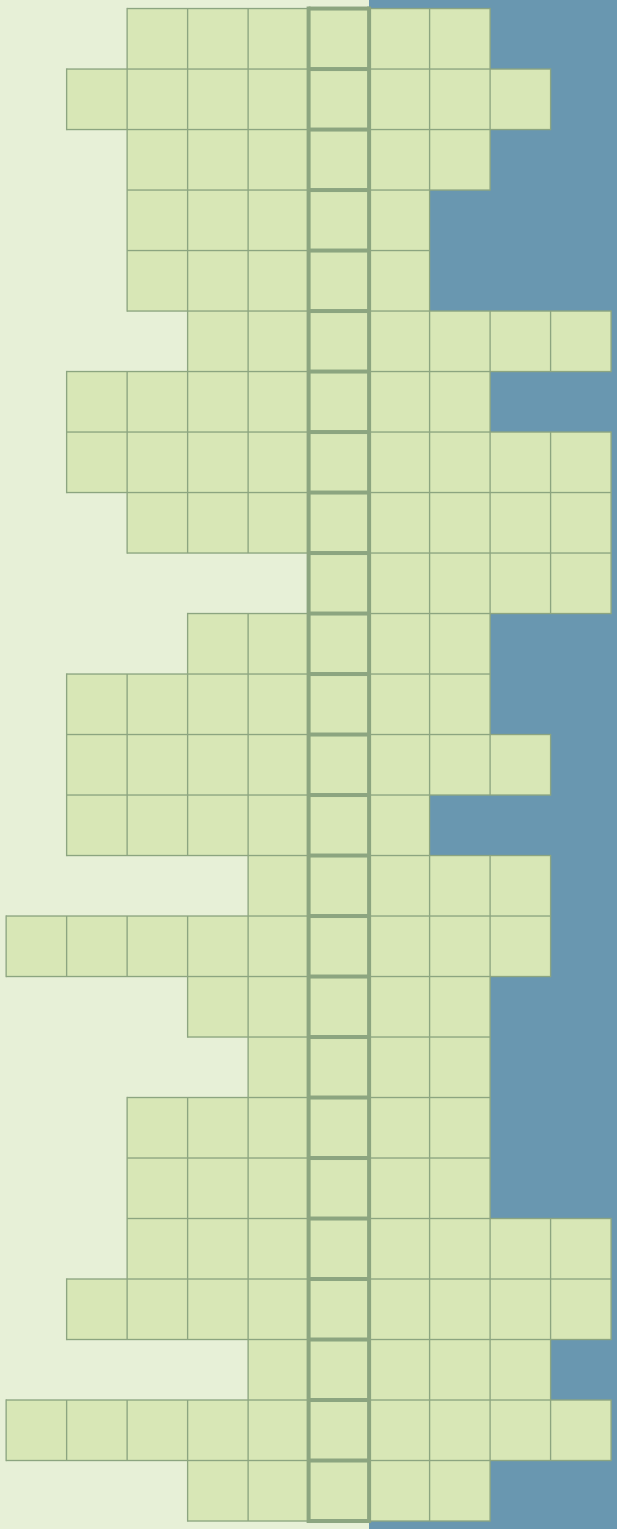
CROSSWORD

The highlighted column in the middle will reveal something that stops damage from an extreme natural phenomenon.

//// ANSWERS ON PAGE 58 ////



1 To use; to give someone a job.

2 Someone who sells to the end user.

3 The space at the edges of a page; the percentage of profit added on to the cost price.

4 A specialised segment of a market.

5 How deep something is.

6 Another word for under or below.

7 A copy; an imitation.

8 Not cheap.

9 A level of wages or salaries.

10 _____ of concept: this will show that your business idea has a good chance of success.

11 Transport for goods or people across a river, for example.

12 To make better; to enhance.

13 The length of time something lasts.

14 _____ flight: the first time a plane takes to the skies.

15 Self contained underwater breathing apparatus.

16 A benefit; a plus point; a positive aspect.

17 Wet; damp.

18 Objective; target.

19 _____ pad: the place from where a rocket lifts off.

20 A plane without an engine.

21 A prediction, about the weather, for example.

22 A digger; a machine for moving earth.

23 The passage between the seats in an airplane, or in a church.

24 If something is able to let electricity flow through it, then it is this.

25 Harvest; the amount of something produced; percentage return on an investment.

< PHOTO: FLINDERS UNIVERSITY >

Die meisten Archäologen schauen nach unten in den Dreck, Dr. Alice Gorman dagegen blickt hinauf zu den Sternen. Sie ist Weltraumarchäologin, eine Pionierin dieser jungen Disziplin. Das Weltraumzeitalter mag noch jung sein, doch die Menschheit hinterlässt bereits ihre Spuren im All in Form von Artefakten und Dokumenten. Gormans Studium von Astroarchäologie, Weltraumschrott und dem kulturellen Erbe der Weltraumforschung setzt alles in den historischen Kontext.

SPACE – THE FINAL DIG

Most archaeologists look down into the dirt, but Dr Alice Gorman is looking up to the stars. She is a space archaeologist, a pioneer in this emerging *new field. The space age may be young, but humankind is already leaving its mark in space in the form of artefacts and documents. Gorman's study of* archaeoastronomy, orbital debris *and the cultural* heritage *of space* exploration *helps* provide *the historical context.*

“ Could you define Space Archaeology in a few words?
Space Archaeology is the study of the material culture of space exploration in the 20th and 21st centuries.

“ Can you explain how space archaeology *emerged* as an area of research per se?
There are two main *stages*: In the 80s and 90s, there was a handful of American archaeologists interested in that area. But at the time, space archaeology was seen as a *quirky* thing. The turning point was around 2003, when Beth Laura O'Leary of New Mexico State University, John Campbell of James Cook University and I put the cultural *value* of space artefacts back on the table. During the 2003 World Archaeological Congress, John *proposed* for the first time a session on space archaeology situated within a broader theme of archaeoastronomy – the study of astronomical knowledge of past cultures. From 2007 onwards the *dedicated* literature reached a critical mass and started to *attract* the interest of media, hard scientists and engineers.

“ Do you think the importance of social science is generally *underestimated* in the space sector?
Yes, I do. The space sector is dominated by engineers and scientists. Most of them are unaware of the methods of social science and the main philosophical and social questions around science.

The thing that really *annoys* me is the *narrative* around the human *urge* to *explore*. What is interesting is that this urge to explore somehow doesn't seem to *apply* to countries such as Nigeria as much as to the United States. The instrumentalisation of human *behaviour* is used to *justify contemporary* space exploration and military development as they *piggy-back* on that narrative by *referencing* to a deep human past of which they know little. I think one of the reasons why social science and *humanities* are important is that people from other disciplines can bring new insights and make narratives of space more *nuanced* and more *appealing* to the general public.

“ What can the study of space debris from a cultural perspective bring to the ongoing political debate on the *issue*?
There are a few things worth *mentioning*. The first one is to recognize that space artefacts are not simply *chunks* of metal that are all the same. If you worked at a *facility* which tested or *manufactured* a certain kind of satellite, you have a special connection to it and space archaeology *validates* these feelings.

There are some other aspects to this as well. I believe the *protection* of cultural heritage in space could help *implement* a fairer use of outer space among nations. Hypothetically, if a country can't prove its presence in the past in a particular orbit, its *access* to this particular orbit might be *denied*. It brings us to the point that *preserving* your own

cultural heritage might then actually have very serious political *implications*. This was used in *courts* on Earth before.

“ There is an *odd* paradox in the space sector: Space technology has been instrumentalised by politicians to *intimidate* since the beginning of the Space Era but also used in science diplomacy to bridge *gaps* between countries.

I cannot think of any other industry that is quite like this. Even during the Cold War, there was a *huge* amount of cooperation going on and a wide *range* of complex interactions that do not necessarily get *acknowledged* in *accounts* of the Space Race. Something that I find interesting which *relates* to that phenomenon is the Overview Effect: This idea that when the first astronauts came back, they were found to have had these *profound* responses to seeing the Earth from the outside and felt connected to all humankind. However, some critics see that this way of looking at the Earth from the outside and seeing it as a whole is a capitalist, white, industrial perspective of the Earth and think there are huge cultural differences in the way people *perceive* the Earth.

“ Would you say that Voyager 1 is the most valuable cultural artefact in Outer space?

It has high historical significance as the first object that left the Solar System. Its aesthetic significance is possibly not that interesting as it is not that *dissimilar* to other kinds of satellites and deep space *probes* sent at the time. However, for an alien that finds it, everything about it is going to be fascinating! Its social value is very high as many people are interested in Voyager 1. It really is *considered*, unlike the Apollo 11 site, to be an *envoy* of all humanity. The further away it is, the more it represents all of humanity because no one can *co-opt* its values for their own agendas. The scientific value rests on its *rarity*, the golden records and their changing meaning over time. In short, Voyager 1 has a high heritage value but we can only say if it is the most valuable cultural artefact if we do a current *survey* of cultural significance for all the other major spacecraft in the Solar System. <<< >>>

Dieses von Martin Sarret geführte Interview ist ursprünglich auf dem SPRU Students Blog erschienen und wird hier mit freundlicher Genehmigung der Autoren veröffentlicht. Das wesentlich umfangreichere Original-Interview findet sich unter
https://sprublog.wordpress.com/2016/06/08/a-tea-break-with-professor-alice-gorman

http://zoharesque.blogspot.de
Blog von Dr. Alice Gorman zum Thema Weltraumarchäologie.

www.flinders.edu.au/people/alice.gorman
Homepage von Dr. Alice Gorman an der australischen Flinders Universität in Adelaide.

www.youtube.com/watch?v=x5fn-iycWBs
TED-Vortrag von Dr. Alice Gorman.

access // 'ækses	*Zugang*
account	*Bericht, Erzählung*
acknowledge, to	*würdigen, anerkennen*
annoy, to	*nerven, verärgern*
appeal, to	*gefallen, reizen*
apply, to	*gelten, zutreffen*
archaeoastronomy // ˌɑːkiɒə'strɒnəmi	*Astroarchäologie*
attract, to	*anlocken, anziehen*
behaviour // bɪ'heɪvjə	*Verhalten, Benehmen*
chunk	*Brocken, Klumpen*
co-opt, to	*etwa: nutzen*
consider, to	*erachten, ansehen*
contemporary	*zeitgenössisch, gegenwärtig*
court	*Gericht*
dedicated	*hier: zugehörig, Fach-*
deny, to	*verweigern, absprechen*
dig	*Grabung, Ausgrabung*
dissimilar	*unähnlich, verschieden*
emerge, to // i'mɜːdʒ	*aufkommen, entstehen*
envoy // 'envɔɪ	*Gesandter, Bote*
exploration	*Erkundung, Erforschung*
explore, to	*erkunden, erforschen*
facility	*Werk, Einrichtung*
gap // gæp	*Kluft, Abstand*
heritage // 'herɪtɪdʒ	*Erbe, Tradition*
huge // hjuːdʒ	*riesig, gewaltig*
humanities	*Geisteswissenschaften*
implement, to	*einführen, umsetzen*
implication	*Auswirkung, Folge*
intimidate, to	*bedrohen, einschüchtern*
issue // 'ɪʃuː	*Sache, Angelegenheit*
justify, to	*rechtfertigen, begründen*
manufacture, to	*herstellen, fertigen*
mention, to	*erwähnen, nennen*
narrative // 'nærətɪv	*Schilderung, Bericht, Erzählung*
nuanced // 'njuːɑːns	*differenziert, nuanciert*
odd	*seltsam, eigenartig*
orbital debris // 'ɔːbɪtl 'debriː	*Weltraumschrott*
perceive, to // pə'siːv	*wahrnehmen, betrachten*
piggy-back, to	*hier: aufsetzen, sich anhängen*
preserve, to // prɪ'zɜːv	*bewahren, schützen*
probe	*Sonde*
profound	*intensiv, tiefgreifend*
propose, to	*vorschlagen, einbringen*
protection	*Schutz, Wahrung*
provide, to	*verschaffen, bieten*
quirky // 'kwɜːki	*sonderbar, schrullig, schräg*
range	*Bereich, Spektrum, Reihe*
rarity	*Seltenheit*
reference, to	*sich beziehen, hinweisen*
relate, to	*sich beziehen, zusammenhängen*
stage	*Phase, Stufe*
survey // 'sɜːveɪ	*Untersuchung, Erhebung*
underestimate, to	*unterschätzen, verkennen*
urge // ɜːdʒ	*Drang, Verlangen*
validate, to	*bestätigen, gültig erklären*
value	*Wert, Nutzen*

CONDUCTIVE MODELLING CLAY

I have already told you how to make an LED light up with a lemon. But did you know that you can also use modelling clay to do the same thing? **Conductive modelling clay**. I learned that from the "Little Engineers" www.kleine-ingenieure.de
I'll show you here how to do it.

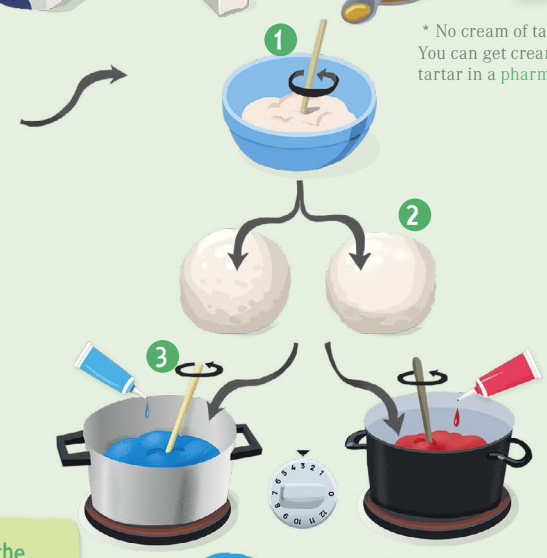
* No cream of tartar? You can get cream of tartar in a pharmacy.

YOU NEED CONDUCTIVE MODELLING CLAY:

- 210 g flour
- 140 ml water
- 70 g salt
- 60 g cream of tartar*
- 2 tbsp vegetable oil
- food colouring blue and / or red

HERE'S WHAT TO DO:

1. Mix everything except the food colouring in a **bowl**.
2. Divide the mixture up into two pieces.
3. Add the food colouring and then **stir** it in on a low heat.
4. Let the **lumps** cool down and then **knead** them with your hands.
5. Keep it fresh.



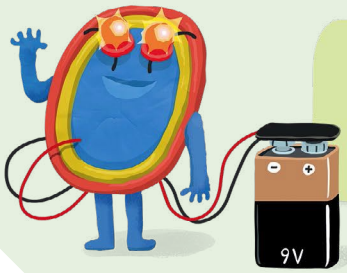
YOU NEED INSULATING MODELLING CLAY:

- 210 g flour
- 80 g sugar
- 6 tbsp vegetable oil
- 120 ml water
- food colouring yellow

HERE'S WHAT TO DO:

1. Mix everything except the food colouring in a bowl.
2. Add the food colouring.
3. Knead the mixture.
4. Keep it fresh.

The clay conducts the current because of the little grains of salt that are released in the water.



On the Little Engineers' website you will learn how to build electric **circuits** with the modelling clay, a battery, two cables and some LEDs.
kleine-ingenieure.de/leitende-knete/stromkreise

VOCABULARY

conductive	stromleitend
modelling clay	Knete
flour	Mehl
cream of tartar	Weinsteinbackpulver
tbsp = tablespoon	Esslöffel
food colouring	Lebensmittelfarbe
bowl	Schüssel
stir	rühren
lump	Klumpen
knead	durchkneten
pharmacy	Apotheke
insulating	isolierend
grain of salt	Salzkörnchen
circuit	Schaltung, Schaltkreis

Die Kinderseite mit Mr. Gylby ist eine Kooperation zwischen dem VDIni Club Magazin des VDI und INCH. Mehr über Mr. Gylby und seine Freunde unter **www.vdini-club.de**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magnet
housing
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9V (block) battery
button/ coin cell
pouch cell
automotive battery
lantern battery
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