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TECHNICAL ENGLISH
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41

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2.2024

AGRIVOLTAICS

WIND-ASSISTED SHIPS

MAGLEV

SUBMERSIBLES

EFFEL TOWER

COOLING WINDOW

SENSORS

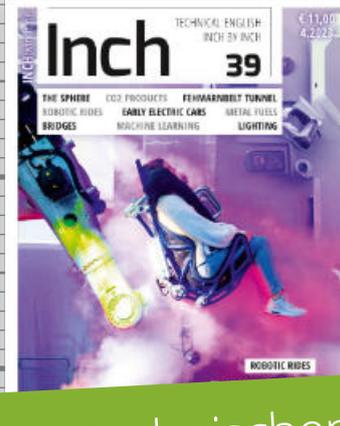
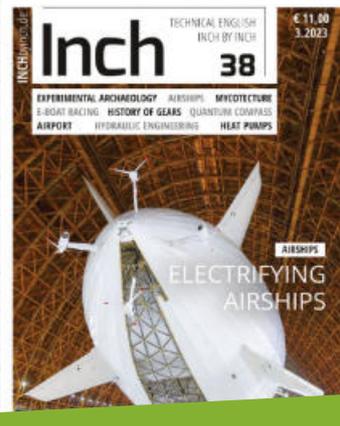
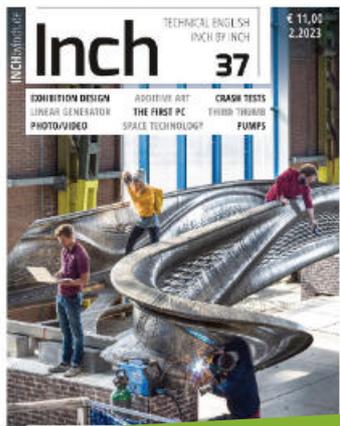
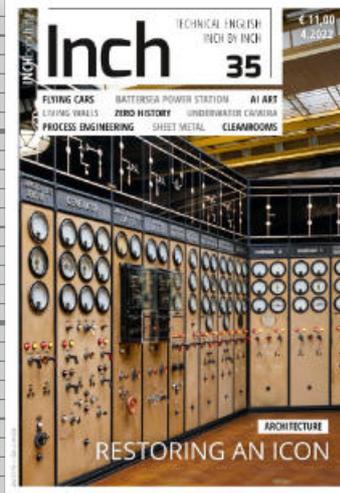
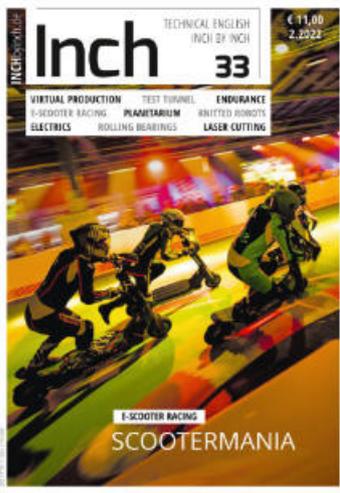
FARMING EQUIPMENT

SURFACE TECHNOLOGY

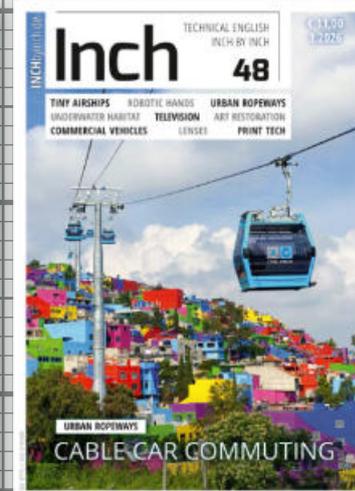
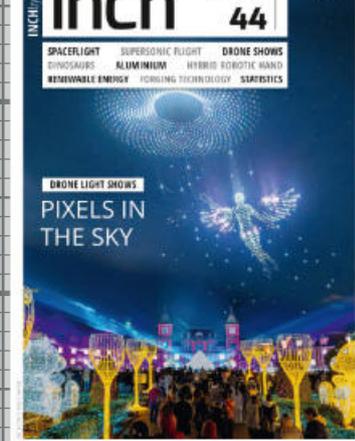
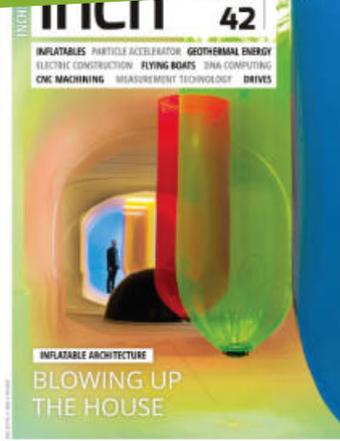


WIND-ASSISTED SHIPS

SAILING TO SPACE



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BROKEN CONTRACT

Die aktuelle Berichterstattung über künstliche Intelligenz hat den Sättigungsgrad schon lange überschritten und es scheint kein Thema rund um Technik und gesellschaftliche Auswirkung von KI zu geben, das nicht schon in aller Ausführlichkeit diskutiert wurde. Nur eine, wie ich finde, sehr wichtige Frage scheint dabei zu kurz zu kommen: Wollen wir KI-generierte Inhalte überhaupt lesen?

Zugegebenermaßen ist das eine eher akademische Frage, denn zum einen lesen wir sicher jetzt schon viele maschinell erzeugte Texte, ohne dass es uns überhaupt auffällt, zum anderen wird uns über kurz oder lang nichts anderes übrig bleiben, wenn wir auch in Zukunft noch informiert sein wollen. Trotzdem oder gerade deshalb bewegt mich beim Lesen in letzter Zeit immer öfter die Frage, ob der Text vor mir nun von einem Menschen oder einer Maschine stammt.

Die Schrift ist eine der größten Erfindungen der Menschheit, erlaubt sie uns doch, unsere Gedanken über Raum und Zeit hinweg zu übertragen. Lesen, also sich mit den Ideen und Vorstellungen von anderen zu befassen, kostet immer Zeit und Mühe, mal mehr, mal weniger. Auf der anderen Seite ist ebenfalls ein Mensch, der sich Zeit für das Strukturieren seiner Gedanken genommen und sich Mühe mit der Formulierung gemacht hat. Es besteht die stille Übereinkunft, dass wir für die „Gedankenübertragung“ einen gegenseitigen Aufwand leisten müssen. Das ist so etwas wie ein unausgesprochener Vertrag zwischen Verfasser und Leser, der so alt ist wie die Schrift selbst.

Dieser Vertrag wird nun mit KI-generierten Texten einseitig aufgekündigt. Es ist das völlig aus der Balance gebrachte Verhältnis zwischen Lese- und Schreibaufwand und das weitgehende Fehlen des menschlichen Gegenübers, das mich umtreibt. Ich muss achtgeben, nicht jeden Text gleich unter den Generalverdacht eines Vertragsbruchs zu stellen und mir damit die Freude am Lesen zu nehmen.

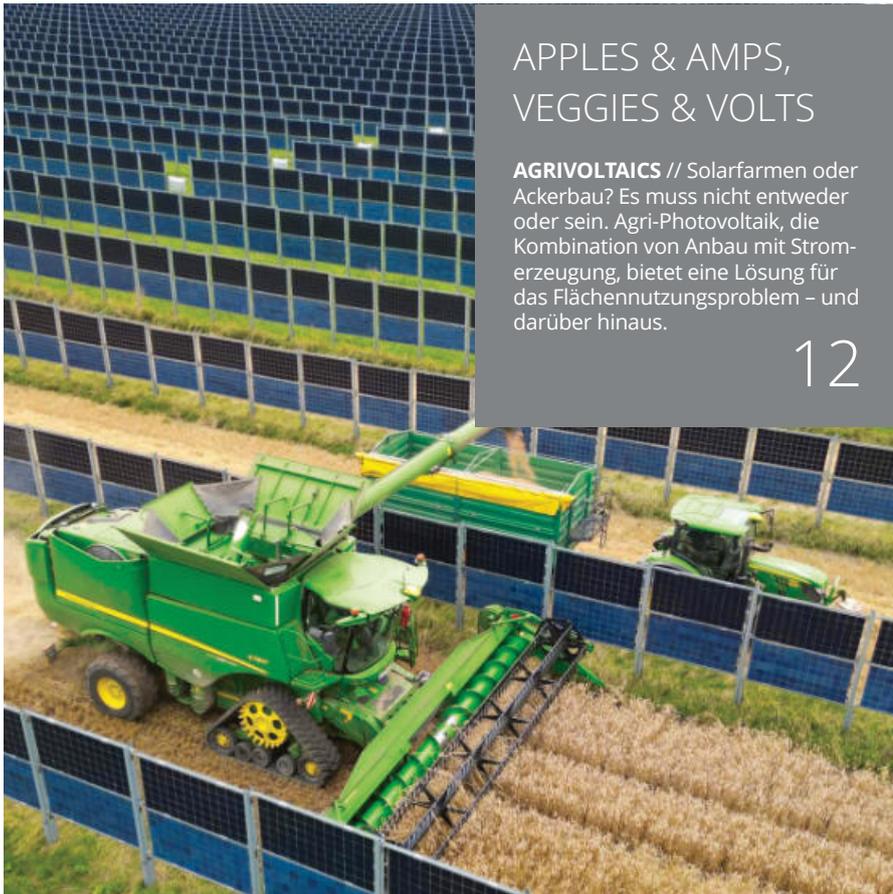
Immerhin können Sie, liebe Leserinnen und Leser, die folgenden 64 Seiten völlig unbeschwert genießen. INCH ist und bleibt „made by humans“. Hinter allen Texten, Bildern und Übungen in diesem Heft stecken echte Menschen, die Jahrzehnte von Erfahrung mitbringen, lange über der Auswahl von Sprach- und Technikthemen brüten und mit Worten und Formulierungen ringen, um Ihnen das Lernen und die Pflege Ihres technischen Englisch so leicht wie möglich zu machen. Wir sind für Sie da.

Matthias Meier

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

P.S.: Auch thematisch ist diese Ausgabe von INCH diesmal erfrischend KI frei. Wir berichten von segelnden Raketentransportern, dem friedlichen Nebeneinander von Solarzellen und Salat, schicken Tauchbooten für zwei, magnetischen Zügen und dem Mast von Paris. Viel Vergnügen mit dieser Ausgabe von INCH.

< COVER: TOM VAN OOSSANEN/ARIANEGROUP >



APPLES & AMPS, VEGGIES & VOLTS

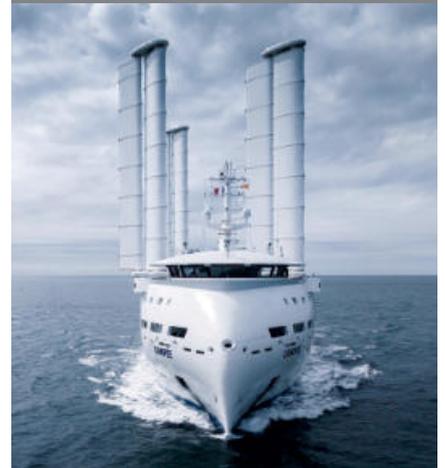
AGRIVOLTAICS // Solarfarmen oder Ackerbau? Es muss nicht entweder oder sein. Agri-Photovoltaik, die Kombination von Anbau mit Stromerzeugung, bietet eine Lösung für das Flächennutzungsproblem – und darüber hinaus.

12

SAILING TO SPACE

WIND-ASSISTED SHIPS // Canopée transportiert Teile der Europarakete Ariane 6 über den Atlantik und ist das erste RORO-Schiff, das auch mit Windkraft angetrieben wird. Vier große, vollautomatische, vertikale Segeltragflächen reduzieren den Kraftstoffverbrauch beträchtlich.

6



WHERE IN THE WORLD IS MAGLEV?

MAGLEV // An der Magnetschwebetechnik wird seit Jahrzehnten gearbeitet. Nach ein paar gescheiterten Experimenten in der ganzen Welt scheint die Technologie heute nur noch in Ostasien erfolgreich eingesetzt zu werden.

36



INTERVIEW



JAN VON HERLE

Elektroautos sind sehr erfolgreich und stoßen kein CO₂ aus. Warum also nach alternativen Lösungen suchen?

62



SUPERCAR SUBMARINE

SUBMERSIBLES // Supersportwagen sind sowas von gestern. Wie wär's mit einem Tauchboot? Nemo ist ein schnittiges Freizeit-U-Boot für zwei Personen, das der Supersportwagen der Tiefe werden könnte.

28

< PHOTOS: KNOBLAUCH/NEXT2SUN, ARIANEGROUP, MARYLAND GOVPICS/WIKIMEDIA, EPFL, U-BOAT WORX, LOUIS-ÉMILE DURANDELLE >

Inch

TECHNICAL ENGLISH
INCH BY INCH

41

EDITORIAL _____	1
TECH CLIPS _____	4
MUSEUM STOP _____	11
TOY STORY _____	17
PINBOARD _____	57
IMPRESSUM // TEAM _____	60
MR GYLBY'S KIDS' CORNER _	64

COOLING WINDOW

LAB REPORT // Forschende am KIT haben ein neues polymerbasiertes Material entwickelt, das gleichzeitig Sonnenlicht ins Innere lässt, für ein angenehmeres Raumklima sorgt und sich selbst reinigt. Das Material könnte Glaskomponenten in Wänden und Dächern ersetzen.

33

THE PYLON OF PARIS

HISTORY // Der Eiffelturm ist eigentlich gar nicht Eiffels Turm: Er wurde vom Wind geformt, von einem Schweizer geplant und berechnet, von einem Architekten verziert und er entstand in einem Kampf zwischen einem Mast und einem Leuchtturm.

46



ISSUE 41 // 2.2024

ENGINEERING

PICTORIAL _____ FARMING EQUIPMENT	18
DICTIONARY _____ SURFACE TECHNOLOGY	20
ENGINEERING BASICS _ SENSORS & TRANSDUCERS	22
DRAWING BOARD _____	34
THE MANUAL _____	45
LISTEN IN _____ FAST PRESSES	54

BUSINESS

ARTS & CULTURE ____ TALKING IN SPACE AND TIME	24
BUSINESS _____ INFLUENCERS AT WORK	26

LANGUAGE

MIXED UP _____	35
FLOW CHAT _____ CHECKING INTO A HOTEL	42
REVERB _____	43
WORD COMBINATIONS _____	44
FEATURE REVIEW _____	52
TONGUE & GROOVE _____	55
GRAMMAR _____ SINGULAR OR PLURAL VERBS	56
ANSWERS _____	58
CROSSWORD _____	61



< PHOTO: JAMES BRUTON >

THE WHEREVER BIKE

Omnidirectional wheels can sometimes be found on *forklifts* which can go sideways – or any other direction – and turn on the spot. British Youtuber James Bruton thought it might be a good idea to put these kind of wheels on a bike. His “screw bike” is certainly one of the weirdest two-wheelers ever made.

For starters, it’s actually a four wheeler. To make full use of differential wheel *motion*, Bruton opted for Mecanum wheels with their rollers set at diagonal angles. Two such wheels with independent drives can move in any direction. An additional set of wheels adds the ability to rotate. One set of wheels is mounted at the front of the bike, the other at the rear – all on a *common* axis and *perpendicular* to normal wheels! Luckily, the contraption is self-balancing. Directional motion can be controlled simply by leaning and turning via two *twist grips*. Video: <https://youtu.be/nfna15r4EXM>

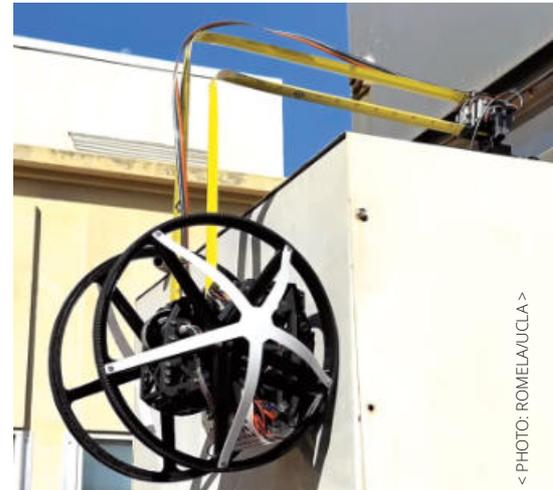
MOVING WITH MEASURING TAPE

Metal pocket measuring tapes are great – not just for measuring things. We have all played around with these tapes, used them as sticks to *poke* or grab things and explored when and how they bend. So did some researchers at UCLA’s Robotics & Mechanisms Laboratory and they designed a self-balancing robot with an *extendible* tape measure *limb*.

The limb is literally made from an old measuring tape that *loops* around an end-effector and a motorized spool. When the tape is extended, the end-effector moves out and magnetically takes hold on a metal *surface* to pull the rest of the bot up. The tape limb can even reach around corners: Blocking the *pulley* in the end-effector causes the tape to *bunch up* and *kink* at a right angle, letting the magnet reach its otherwise *inaccessible* target.

www.romela.org

Video: <https://youtu.be/DUqitknvWo>



< PHOTO: ROMELA/UCLA >

CYCLE SUBMARINE

Pedalling is a much more efficient use of leg power than walking or running – cyclists have known that for centuries. It was only recently, however, that the principle was adopted for use under water. Seabike’s “underwater mobility devices” are basically *unicycles* with a propeller instead of a wheel.



< PHOTO: SEABIKE >

The long *pole* with pedals and a propeller at the end is simply *strapped* to the *waist* with a belt. Jump in the water, step into the pedals and off you go. Do the crawl with your arms and you can even go faster. The *nifty* water bike works on the surface as well as completely *submerged* and can therefore be used by swimmers and divers alike. Finally, *mediocre* swimmers like me have something better to do with their legs than *aimlessly flapping* them about.

www.seabike.fr

PENGUINS DO IT FASTER

Penguins are excellent and fast swimmers. So why not use their shape for an autonomous underwater vehicle for collecting geo-referenced data on various physical water parameters. That's how Evologics' Quadroin was *conceived*: In shape, size – and colouring – the AUV is *strikingly* similar to a king penguin, except for its four propellers instead of *webbed feet*, which, thanks to its low-drag shape, push the Quadroin to speeds of up to ten knots. A range of sensors, including HD underwater cameras and a side-scan sonar for acoustic seafloor imaging, collect data which is transmitted via the robo-penguin's '*flipper*', a *collapsible* antenna, once the AUV *surfaces*.

For those who find the look of the Quadroin somewhat familiar: In 2009, an early concept demonstrator was featured as one of Festo's *annual* bionics projects.

<https://evologics.com/robotics>



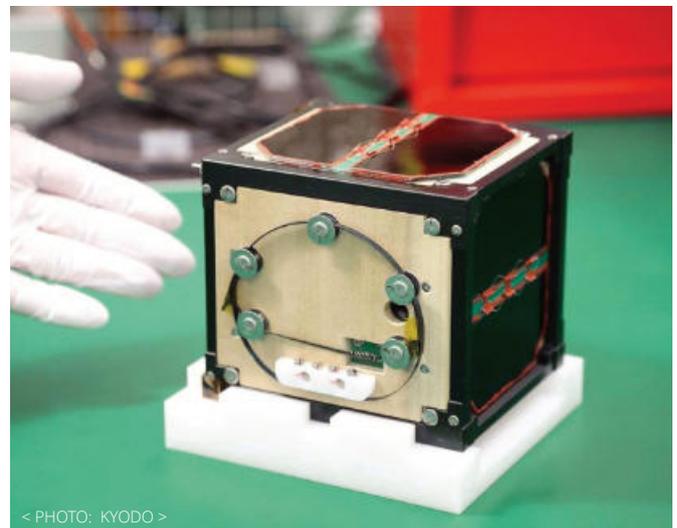
< PHOTO: EVOLOGICS >

adhesive // əd'hi:sv	Klebstoff
aimlessly	ziellos, sinnlos
annual	jährlich
bunch up, to	sich bauschen
circuit // 'sɜ:kɪt	hier: Schaltkreis
collapsible	zusammenlegbar, einklappbar
common	gemeinsam, gemeinschaftlich
conceive, to // kən'si:v	entwerfen, konzipieren
drag	Strömungswiderstand
durability	Haltbarkeit, Robustheit
environment // ɪn'vaɪrənmənt	Umwelt, Umgebung
extendible	ausfahrbar, ausziehbar
flap, to	schlagen, schlackern
flipper	Flosse
forklift	Gabelstapler
inaccessible	unzugänglich, unerreichbar
kink, to	abknicken
launch, to // lɔ:ntʃ	starten
limb // lɪm	Gliedmaße, Extremität
loop, to	schlingen, winden
measuring tape	Maßband
mediocre // ,mi:di'əʊkə	mittelmäßig, leidlich
motion // 'məʊʃn	Bewegung
nifty	raffiniert, elegant
perpendicular // ,pɜ:pən'dɪkjələ	senkrecht
poke, to	stochern, stoßen
pole	Stange, Stab
pulley // 'pʊli	Umlenkrolle, Riemenscheibe
strap, to	festschnallen
strikingly	auffällig, auffallend
submerge, to // səb'mɜ:dʒ	abtauchen, eintauchen
surface // 'sɜ:fɪs	Oberfläche
surface, to // 'sɜ:fɪs	an die Oberfläche kommen
target // 'tɑ:gɪt	Ziel
trace	Spur
twist grip	Drehgriff
unicycle // 'ju:nɪsaɪkl	Einrad
waist	Taille
webbed feet	Schwimmfüße

TREES IN ORBIT

The Japanese are absolute masters in combining the traditional with the modern. Therefore, it's little wonder that the first wooden satellite is 'made in Japan'. The 'Ligno-Sat' is a 10-centimeter cubesat made from 5 millimeter-thick magnolia wood panels, with a frame partially constructed from aluminium. It is built based on a traditional Japanese technique that does not use any screws or *adhesive* materials.

The *durability* of the wooden material in the harsh *environment* of outer space has been tested before. The wooden satellite will be *launched* from the ISS in September and it should burn up during re-entry without leaving any harmful *traces*. The researchers are hoping that future low-cost satellites can be made entirely from wood – including the substrate for the electronic *circuits*. www.kyoto-u.ac.jp



< PHOTO: KYODO >

WIND-ASSISTED SHIPS

*Europas neue Rakete Ariane 6 erreicht ihren Startplatz mit Hilfe des Windes. Die Träger-
rakete wird von Canopée über den Atlantik transportiert, dem ersten RORO-Schiff, das
auch mit Windkraft angetrieben wird. Vier große, vollautomatische, vertikale Segeltrag-
flächen reduzieren den Kraftstoffverbrauch des Hybrid-Schiffs beträchtlich.*



SAILING TO SPACE

< ALL PHOTOS: ARIANEGROUP >

Europe's new heavy-lift rocket Ariane 6 is relying on the wind to get to the pad: The launcher is being shipped across the Atlantic aboard *Canopée*, the first wind-assisted RORO vessel with wingsails. Four large, fully automatic vertical wings significantly reduce the fuel consumption of the hybrid vessel.

Seafaring and space travel share a strong connection: After all, most of the Space Shuttles were named after historic naval vessels, and astronauts, which is Greek for 'star sailors', are still 'docking' their 'spaceships' at the International Space Station. It therefore may come as little surprise that parts of Ariane 6, Europe's new heavy-lift rocket, are being shipped to the 'space port' in Kourou, French Guiana, aboard a sailing vessel – or the space-age version of a sailing vessel to be precise.

The custom-built *Canopée* is an open-top RORO cargo ship which could easily be mistaken for just another one of those pick-up trucks of the sea – if it weren't for the four giant masts with wing-like sails mounted atop the sides of the cargo hold. These sails are much more than just a romantic reference to the age of windjammers or yet another nod to the sea/space analogy; their addition was mainly an economic decision as they can reduce the fuel consumption of *Canopée*'s two diesel engines by up to 30 percent.

call for tenders	Ausschreibungsverfahren
cargo hold	Laderaum
challenging // 'tʃælɪndʒɪŋ	herausfordernd, schwierig
competitive	wettbewerbsfähig
consumption	Verbrauch
convince, to	überzeugen, überreden
core	Kern, Innenteil
custom-built	speziell gebaut, maßgeschneidert
decision // dɪ'sɪʒn	Entscheidung, Entschluss
expertise // ,ekspɜ:'ti:z	Fachwissen, Know-how
foray // 'føreɪ	Vorstoß
issue, to	herausgeben, erstellen
launch // 'lɔ:ntʃ	Start
launch provider // 'lɔ:ntʃ prəvaɪdə	Startdienstleister
launcher // 'lɔ:ntʃə	Trägerrakete
mistake, to (mistook, mistaken)	falsch verstehen, verwechseln
naval // 'neɪvl	Marine-
naval architectural firm	Schiffsarchitekturbüro
naval engineer	Schiffbauingenieur/in
nod	Nicken, Wink
pad	hier: Startrampe
prediction	Vorhersage, Prognose
preliminary // prɪ'lɪmɪnəri	vorläufig, vorbereitend
proposal	Angebot, Vorschlag
RORO	roll-on, roll-off
seafaring	Schiffahrt, Seefahrt
seek, to (sought, sought)	suchen, fragen nach
shallow	seicht, flach
subsequently // 'sʌbsɪkwəntli	später, danach, in der Folge
surprise	Überraschung, Verwunderung
sustainable	nachhaltig, umweltverträglich
vessel // 'vesl	Schiff, Seefahrzeug
wingsail	Tragflächensegel

While working on the latest iteration of its Ariane rocket, European launch provider Arianespace was looking for a more sustainable solution to transport rocket parts from various ports in Europe across the Atlantic to ESA's launch facilities in South America. In 2018, they issued a call for tenders for a competitive and environmentally-friendly logistics solution.

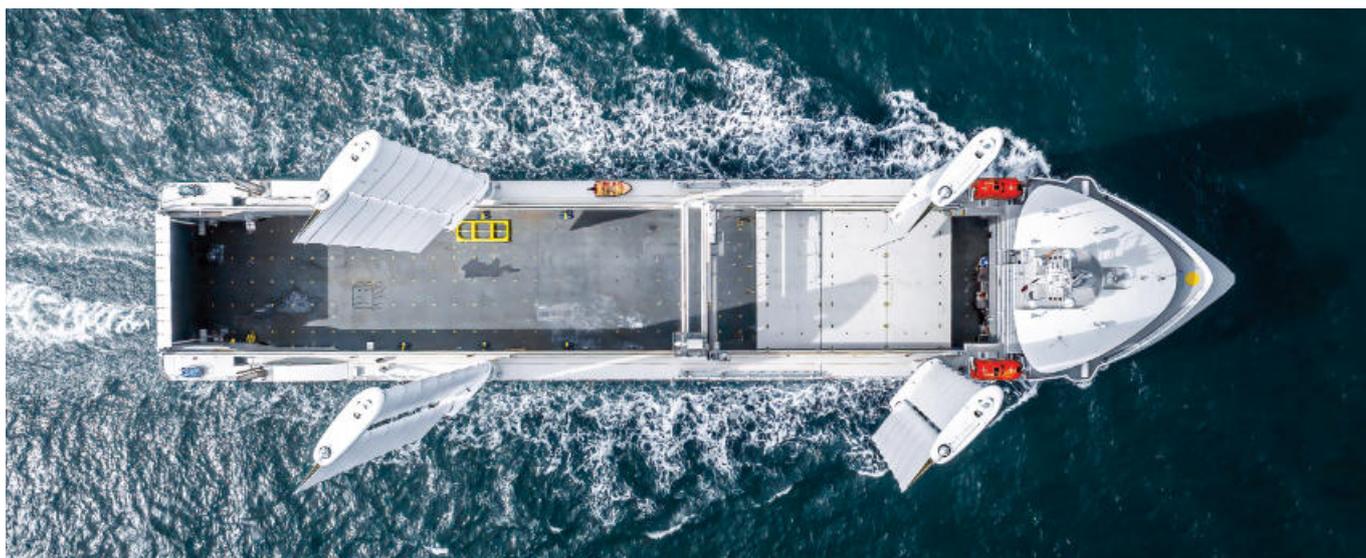
FROM SUPER YACHTS TO CARGO VESSELS

One of the proposals came from a most unlikely candidate: While the naval architectural firm VPLP Design has designed an impressively long list of prize-winning and record-breaking sailing yachts and racing boats they had never before worked on a commercial vessel. This was their first foray into the world of decarbonized shipping under sail. Thanks to their expertise in sails, wings and ocean winds, however, they were able to run convincing simulations on the potential fuel savings. Subsequently, the shipping company Zéphyr & Borée and ship owner Jifmar Offshore Services joined the project and established the Alizés shipping company, which won the tender. For the final design Alizés sought the expertise of the Dutch shipbuilder Neptune Marine Projects, who turned the VPLP Design's preliminary concept and hybrid performance prediction into an actual vessel.

Designing the 121-meter-long *Canopée* was challenging in many ways. Its freight, the various parts of the Ariane 6 rocket including the giant central core of the first stage, is as massive as it's delicate. The high-tech equipment requires speedy but stable transport not only across open sea but also in the shallow waters of the Kourou river. Consequently, the naval engineers had to come up with a >>>



Canopée's four reefable wingsails can reduce the RORO cargo ship's fuel consumption by up to 30 percent.



Equipped with a bridge crane and a flexible tween deck the *Canopée* is custom-built to transport Ariane 6 parts across the Atlantic.

special *hull* shape able to reduce the river *draft* down to 3.8 meters while at the same time allowing the two 3480-Kilowatt Diesel engines to push the vessel to its design speed of 16.5 knots at sea. Additionally, a combination of anti-roll and *anti-heeling tanks* ensure that the *transverse, longitudinal* and vertical *accelerations* don't exceed the set criteria.

While these are impressive naval engineering *feats* in itself, the most *striking* feature of the *Canopée* is of course its sails – which are actually wings. The four fully automated and *collapsible* vertical wings are designed and *manufactured* by the French start-up and VPLP Design spin-off Ayro.

REDISCOVERING THE FORCE OF THE WIND

Wind-assisted hybrid *propulsion* cargo vessels are *by no means* a new concept. The idea to *tap* the winds to reduce fuel consumption and CO₂ emissions has been around for decades – although more as an experimental concept. In recent years, however, 'the wind has been picking up' and currently over 35 hybrid wind-assisted vessels are in operation worldwide.

While the number may seem low, adding wind into the propulsion mix isn't as easy as it may seem: The *aeolian* forces *tugging* at the vessel have a strong *impact* on its stability, structural integrity, weight distribution and *manoeuvrability*. As a result, the effectiveness of wind propulsion depends heavily on the design of the vessel and its operational practices. *Retro-fitting* a vessel with a wind propulsion technology is therefore often less effective than designing a hybrid vessel from the ground up, as is the case with *Canopée*.

Be it retro-fitted or newly built, the modern versions of *clippers* and windjammers *bear little resemblance* to their historic *forbearers*: Instead of *billowing* sails, most of them rely on rotating cylinders, *kites* or wings to catch the wind.

The first sailing vessel without an actual sail was Robert Flettner's 'Baden-Baden'. Flettner replaced the vessel's masts

with two giant rotating cylinders to make use of the Magnus effect. In 1926, the *odd-looking* vessel successfully crossed the Atlantic. Back then Flettner's idea didn't *catch on*, but in recent years his rotors have been having somewhat of a renaissance: The wind power company Enercon uses its four-rotor E-Ship 1 to ship rotor *blades* around the world and the Finnish company Norsepower is successfully re-fitting *ferries* and tankers with Flettner rotors (see INCH 29 | Rotor Sail Renaissance).

Traction kites are another wind-assisted technology with the potential to reduce fuel consumption. In 2007, the German company Skysails equipped the freighter MS Beluga Skysails with a fully automated system to *launch* and *retract* a 160-square-meter kite. Unfortunately, the fuel reduction wasn't as high as expected and the company *abandoned* the project and *reverted* to land-based power-generating kites (see INCH 24 | Kite Power). The latest kite-powered vessel is the 'Ville de Bordeaux', a RORO vessel chartered by Airbus. Airseas has equipped it with one of its 'Seawings', a 500-square-meter traction kite. The experimental kite, about half the size of the *envisioned* production system, is currently undergoing sea *trials*.

WINGS ARE BETTER SAILS

Unlike rotors and kites, vertical wings are much closer to traditional sails – in *appearance* as well as in function. Back in 2009, VPLP equipped the America's Cup yacht USA 17 with a 58-meter-tall wingsail and a year later the BMW Oracle Racing team won the cup. The trimaran's wingsail, however, was fixed and could only be operated by a highly trained crew.

VPLP realised the huge potential of the wingsail, which is about twice as *performant* as a conventional sail, but also that future versions would have to be *reefable* and fully automatic to be of any use for *recreational* yachts or com-

mercial vessels. Intensive research and development, a few prototypes, many sea trials and a company spin-out later, Ayro's Oceanwings today make the Canopée one of the most *advanced* wind-powered transport ships on the ocean.

Each of Canopée's four wingsails is 33 meters tall and 11 meters wide. It consists of a forward *flap* and an *aft* flap made from modern sail *cloth* with *aerofoil*-shaped stabilizers, both of which can be reefed independently on the fixed mast. The wing allows two main *adjustments*. Firstly, the *angle of incidence* of the wings, which turn 360 degrees in relation to the wind, and the rear flap, which can *pivot* around the secondary mast to create a *camber* in relation to the front flap. As a result, the Oceanwings generate far more power than conventional sails or single-element wings.

The whole system is fully automated and doesn't require a special crew. A *routing* system *suggests* the best routes for maximum fuel savings. The current local wind conditions are then measured and analysed by a software which sends instructions to the individual wings. There electric *actuators* adjust the *angle of attack* and wingsail camber for best performance.

ARIANE 6 SPREADS ITS WINGS

In August 2023, after a first "wing-less" rotation from Europe to Kourou at the end of 2022, the Canopée was *fitted* with its four masts. Just three months later she spread her wings for a double *maiden voyage*. Not only was it the first sea voyage of a RORO cargo ship designed from the ground up as a hybrid windsail-assisted vessel, Canopée also carried parts of the very first Ariane 6, which meant that the trip was also the first *leg* of Europe's new heavy-lift rocket into space.

After unloading, Canopée set sail again and went straight back to pick up Ariane 6's main and upper stage. The rocket is currently being *assembled* and tested in Kourou ahead of its first flight into space in July 2024. >>>

After a static fire test, Europe's new heavy-lift launcher Ariane 6 is ready for its upcoming maiden flight from Kourou.



<i>abandon, to</i>	<i>aufgeben, verwerfen</i>
<i>acceleration</i>	<i>Beschleunigung</i>
<i>actuator // 'æktʃuətə</i>	<i>Stellantrieb, Stellmotor</i>
<i>adjustment</i>	<i>Einstellung</i>
<i>advanced</i>	<i>fortschrittlich, modern</i>
<i>aeolian // i:'əʊliən</i>	<i>Wind-, aeolisch</i>
<i>aerofoil // 'eərəfɔɪl</i>	<i>Tragfläche</i>
<i>aft</i>	<i>achtern, hinten</i>
<i>angle of attack</i>	<i>Anstellwinkel</i>
<i>angle of incidence</i>	<i>Anströmwinkel</i>
<i>anti-heeling tank</i>	<i>Krängungsausgleichstank</i>
<i>appearance // ə'piərəns</i>	<i>Aussehen, Äußeres</i>
<i>assemble, to</i>	<i>zusammenbauen, montieren</i>
<i>bear little resemblance, to (bore, borne/born)</i>	<i>wenig Ähnlichkeit haben</i>
<i>billow, to // 'bɪləʊ</i>	<i>sich blähen</i>
<i>blade</i>	<i>Blatt</i>
<i>by no means</i>	<i>auf keinen Fall, keineswegs</i>
<i>camber // 'kæmbə</i>	<i>Profilwölbung</i>
<i>catch on, to (caught, caught)</i>	<i>hängenbleiben</i>
<i>clipper</i>	<i>Klipper, Frachtsegelschiff</i>
<i>cloth</i>	<i>Stoff, Tuch, Gewebe</i>
<i>collapsible</i>	<i>faltbar, zusammenschiebbar</i>
<i>draft</i>	<i>hier: Tiefgang</i>
<i>envision, to</i>	<i>planen, sich vorstellen</i>
<i>exceed, to</i>	<i>übersteigen, übertreffen</i>
<i>feat</i>	<i>Leistung, Kunststück</i>
<i>ferry</i>	<i>Fähre</i>
<i>fit, to</i>	<i>montieren, einbauen</i>
<i>flap</i>	<i>(Flügel-) Klappe</i>
<i>forbearer // 'fɔːbeərə</i>	<i>Vorgänger/in, Vorfahr/in</i>
<i>hull // hʌl</i>	<i>Schiffskörper, Rumpf</i>
<i>impact</i>	<i>Auswirkung, Einfluss</i>
<i>kite // kaɪt</i>	<i>Flugdrachen</i>
<i>launch, to // lɔːntʃ</i>	<i>starten, hier: steigen lassen</i>
<i>leg</i>	<i>hier: Abschnitt, Etappe</i>
<i>longitudinal // ,lɒŋgɪ'tjuːdɪnəl</i>	<i>längsgerichtet</i>
<i>maiden voyage // 'meɪdn 'vɔɪdʒ</i>	<i>Jungfernfahrt</i>
<i>manoeuvrability // mə,nu:vəə'biləti</i>	<i>Manövrierfähigkeit</i>
<i>manufacture, to // ,mænju'fæktʃə</i>	<i>herstellen, fertigen</i>
<i>odd</i>	<i>seltsam, eigenartig</i>
<i>performant</i>	<i>leistungsfähig, leistungsstark</i>
<i>pivot, to</i>	<i>schwenken, drehbar lagern</i>
<i>propulsion</i>	<i>Antrieb, Schub</i>
<i>recreational // ,rekri'eɪʃənəl</i>	<i>Freizeit-, der Erholung dienend</i>
<i>rediscover, to</i>	<i>wiederentdecken, wiederfinden</i>
<i>reefable</i>	<i>reffbar</i>
<i>retract, to</i>	<i>einziehen, einholen</i>
<i>retro-fit, to</i>	<i>nachrüsten</i>
<i>revert, to</i>	<i>zurückkehren</i>
<i>routing // raʊtɪŋ</i>	<i>Streckenführung</i>
<i>spread, to</i>	<i>spreizen, ausstrecken</i>
<i>striking</i>	<i>markant, auffällig</i>
<i>suggest, to // sə'dʒest</i>	<i>vorschlagen, empfehlen</i>
<i>tap, to</i>	<i>erschließen, anzapfen</i>
<i>traction kite</i>	<i>Zugdrachen</i>
<i>transverse</i>	<i>querlaufend, transversal</i>
<i>trial // 'traɪəl</i>	<i>Versuch, Test</i>
<i>tug, to // tʌg</i>	<i>schleppen, ziehen</i>

Once the oceans were like outer space – empty, *vast* and unknown – and humanity relied on the wind and sails to *explore* them. It's somewhat *reassuring* that, in a way, it's still the wind that takes us to the most distant of *shores*.

<<< Matthias Meier >>>

<i>explore, to</i>	<i>erkunden, erforschen</i>
<i>reassure, to</i>	<i>beruhigen</i>
<i>shore</i>	<i>Küste, Ufer, Gestade</i>
<i>vast // vɑ:st</i>	<i>weitläufig, riesengroß</i>



Links, Vokabeln & mehr unter

www.inchbyinch.de/inch41/wingsails

www.ariane.group/de/neuigkeiten/canopee-das-frachtschiff-fuer-die-ariane-6-setzt-die-segel

Webseite der Ariane Group mit allen Informationen zum Transportschiff Canopée.

<https://ayro.fr/wp-content/uploads/2023/08/DP-CANOPEE-ENG.pdf>

Ausführliche Pressemappe von Alizés und Ayro zur Entwicklung des hybriden Frachtschiffs.

www.vplp.fr/en/maritime/canopee

www.jifmar.net/fleet/canopee

<https://zephyretboree.com/en/projects/canopee>

www.neptunemarine.com/ship-of-the-year-2023-canopee

<https://ayro.fr/projects/shipping>

Canopée Projektseiten der im Artikel genannten, beteiligten Unternehmen.

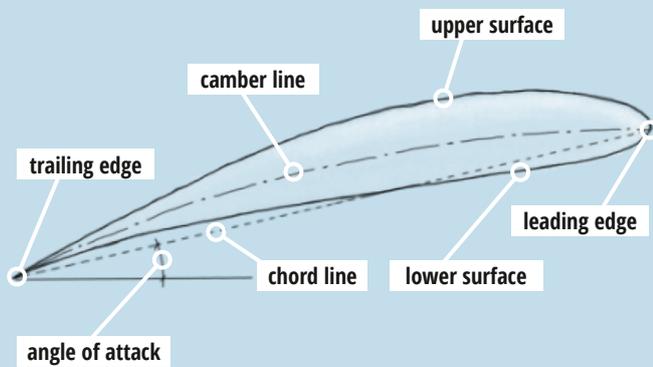
www.esa.int/Enabling_Support/Space_Transportation/Launch_vehicles/Ariane_6

www.ariane.group/de/weltraumstartdienste/ariane-6

Webseiten von ESA und Ariane Group zur Ariane 6 Trägerrakete.

TECH EXTRAS

PICTORIAL AEROFOIL



HOW AN AEROFOIL DOESN'T WORK

Aerodynamic *lift* is often explained by *over-simplified* but basically wrong descriptions.

The most popular incorrect theory known as the “equal transit time” or “longer path” theory, which *states* that *wings* are designed with the upper *surface* longer than the lower surface to generate higher velocities on the upper surface because the molecules of gas on the upper surface have to reach the *trailing edge* at the same time as the molecules on the lower surface. According to Bernoulli, this would create a lower pressure on the upper surface, resulting in a lift force. In reality, however, the velocity on the upper surface is much higher than the velocity which produces an equal transit time.

Another incorrect theory uses a Venturi flow to try to *determine* the velocity. But this also gives the wrong answer since a wing section isn't really half a Venturi *nozzle*.

There is also an incorrect theory which uses Newton's third law applied to the bottom surface of a wing. This theory *equates* aerodynamic lift to a stone *skipping* across the water. It *neglects* the physical reality that both the lower and upper surface of a wing *contribute* to the turning of a flow of gas.

To explain aerodynamic lift correctly, mass, momentum and energy in the flow have to be *conserved* simultaneously as stated by the Euler *Equations* or, including *viscosity*, the Navie-Stokes Equations.

<i>conserve, to</i>	<i>erhalten, bewahren</i>
<i>contribute, to</i>	<i>beitragen, beisteuern</i>
<i>determine, to // dɪ'tɜ:mɪn</i>	<i>bestimmen, ermitteln</i>
<i>equate, to</i>	<i>gleichsetzen, gleichstellen</i>
<i>equation // ɪ'kwweɪʒn</i>	<i>Gleichung</i>
<i>lift</i>	<i>Auftrieb</i>
<i>neglect, to</i>	<i>außer Acht lassen</i>
<i>nozzle // 'nɒzl</i>	<i>Düse</i>

<i>over-simplified</i>	<i>zu sehr vereinfacht</i>
<i>skip, to</i>	<i>hüpfen, springen</i>
<i>state, to</i>	<i>erklären, konstatieren</i>
<i>surface // 'sɜ:fɪs</i>	<i>Oberfläche</i>
<i>though // ðəʊ</i>	<i>jedoch, allerdings</i>
<i>trailing edge</i>	<i>Flügelhinterkante</i>
<i>viscosity // vɪ'skɒsəti</i>	<i>Zähigkeit, Viskosität</i>
<i>wing</i>	<i>Flügel, Tragfläche</i>

Das Musée international d'horlogerie in La Chaux-de-Fonds ist ein Gesamtkunstwerk. Der weitgehend original erhaltene Museumsbau aus dem Jahr 1974 beherbergt die weltweit größte Ausstellung über die Geschichte der Zeitmessung.



< PHOTO: M. MEIER >

This is it? My *expectations* were high, after all I'm in La Chaux-de-Fonds, the historic heart of the Swiss watch industry, about to enter the Musée international d'horlogerie, the world's largest collection *dedicated* to the history of time measurement. The MIH's entrance, however, is somewhat *eerie* and appears to lead into a dark cave – which it actually does as the whole museum is underground. The only *hint* to its *content* is a lonely gnomon, a sundial's pointer, which, for whatever reason, is placed in the shade. I take a deep breath and enter – only to step into a giant time capsule filled to the *brim* with horological wonders.

50 years ago, the then still *flourishing* Swiss watch industry built itself a new showcase, and only the best and most modern was good enough for the architecture and presentation of the MIH. Then the 'quartz crisis' hit, cheap quartz watches cost many of the town's businesses their *livelihood* and, as a result, the museum became frozen in time. While, today, the *concrete* Brutalist architecture may take some getting used to, the overall presentation has a warm 70s flair – including *bubbly* Plexiglas display stands, lots of indirect lighting and sisal *flooring*.

The museum is enormous and, true to its content, you need time to take it all in – lots of time. There are several *designated* ways to *experience* the museum like the main route along the walls which *traces* the history of time measurement in 36 steps, the themed spaces covering aspects like, for example, sky & earth, days & hours or style & *manufacture* and the *treasures* and masterpieces in the 70s bubbles. The best way, however, is probably to lose oneself in the sheer *plenitude* of all the different ways to measure and display time.

Following your own path you may *stumble* across a reconstruction of Giovanni Dondi's Astrarium, a 14th century astronomical clock, the *intricate fob watches* of Ami LeCoultre Piguet or Jaquet-Droz and Leschot or one of François Junod's automata (see INCH 40 | Mechanical Poetry). You can *marvel* at large, *crude* tower clocks or *minuscule ladies' watches*, playful alarm clock designs or *marble*

run clocks. You can explore the beginnings of time measurement with sand, water and the sun or *retrace* the *hunt* for even more precise clocks ticking in femtoseconds.

Just make sure you have a little time left for a small *detour*. The Musée d'Horlogerie du Locle in nearby Le Locle is the perfect contrast. For one, it's not a cave but an *airy country manor* with a focus on old pendulum and *mantle clocks*. While the ornate baroque style might not be everyone's taste the historic automatons and the excellent modern *exhibition* about all aspects of time in the *attic* are certainly worth a visit.

So many clocks, so little time. <<< Matthias Meier >>>

Musée international d'horlogerie
Rue des Musées 29
CH-2300 La Chaux-de-Fonds
Schweiz



www.chaux-de-fonds.ch/de/musees/mih

Musée d'Horlogerie du Locle: www.mhl-monts.ch

<i>airy</i>	luftig, hell
<i>attic</i> // ætik	Dachboden, Speicher
<i>brim</i>	Rand, oberste Kante
<i>bubbly</i>	hier: blasenförmig
<i>concrete</i> // 'kɒŋkri:t	Beton
<i>content</i> // 'kɒntent	Inhalt
<i>country manor</i> // 'kantri 'mæna	Landsitz, Herrenvilla
<i>crude</i>	grob, derb, einfach
<i>dedicate, to</i>	widmen, weihen
<i>designated</i>	festgelegt, vorgesehen
<i>detour</i> // 'di:təʊ	Umweg, Schlenker
<i>eerie</i> // 'iəri	unheimlich, gruselig
<i>exhibition</i> // ekst'bɪʃn	Ausstellung
<i>expectation</i>	Erwartung, Vorstellung
<i>experience, to</i> // ik'spiəriəns	erleben, erfahren
<i>flooring</i>	Bodenbelag
<i>flourish, to</i> // 'flaʊʃ	blühen, gedeihen
<i>fob watch</i>	Taschenuhr
<i>hint</i>	Hinweis, Anhaltspunkt
<i>hunt</i>	Jagd, Suche
<i>intricate</i> // 'ɪntrɪkət	aufwändig, kunstvoll, kompliziert
<i>livelihood</i>	Lebensunterhalt
<i>mantle clock</i>	Tischuhr
<i>manufacture</i> // ,mænju'fæktʃə	Herstellung, Fertigung
<i>marble run</i>	Kugelbahn
<i>marvel, to</i>	staunen, sich wundern
<i>minuscule</i> // minaskju:l	winzig
<i>plenitude</i> // 'plenɪtju:d	Fülle
<i>retrace, to</i>	zurückverfolgen
<i>stumble, to</i>	stolpern
<i>trace, to</i>	nachzeichnen, nachvollziehen
<i>treasure</i> // 'treɪzə	Schatz, Kostbarkeit

AGRIVOLTAICS

Solarfarmen anstelle von Ackerbau können eine einträgliche Alternative für Landwirte sein. Doch es muss nicht entweder oder sein. Agri-Photovoltaik, die Kombination von Anbau mit Stromerzeugung, bietet eine Lösung für das Flächennutzungsproblem – und darüber hinaus.

< PHOTO: KNOBLAU/CHNEXT/SUN >

APPLES & AMPS, VEGGIES & VOLTS

Solar 'farming' instead of growing crops can be a profitable alternative for farmers. But it doesn't have to be either, or. Agrivoltaics, the combination of farming and generating electricity, may be a solution for the land use problem – and beyond.

Photosynthesis or photovoltaics? More and more farmers are *pondering* the question of whether they should 'grow' solar panels *instead of* sunflowers or *wheat*. After all, *harvesting* kilowatts doesn't *require* any dirty and *arduous* field-work and the economics might be better, too. Determining what the best use of the land is can easily turn into an ethical and political minefield. But does it really have to be either, or? Why not both? The growing field of agrivoltaics offers an elegant solution which might be *beneficial* for volts and *vegetables* alike.

Agrivoltaics is the dual use of land for farming and generating electricity. This may sound like a bad compromise, after all there's only so much sun per square meter, but by cleverly splitting the sun's power between photosynthesis and photovoltaics the *net gain* from agricultural land can even be higher than with single *usage*.

It's a simple concept that's been around for a while but has only lately started to *gain* some *traction*. As far back as 1981, Prof. Dr. Adolf Goetzberger, the *late founder* of the Fraunhofer Institute for Solar Energy Systems ISE and his colleague Dr. Armin Zastrow *anticipated* a growing conflict

between using land for solar farms or agriculture. They *argued* that by mounting the solar panels on *elevated* stands high above the crops and *spacing* them more widely apart their shadowing might be *negligible* and for some crops even *advantageous*.

Forty years later the world has changed. We have created a climate crisis which is forcing us to *switch* to renewable energy *sources* and, as a result, the pressure to find suitable land for solar farms is greater than ever. At the same time a growing number of extreme weather conditions such as long *dry spells*, heavy rain or *hail* are *hampering* the growth of crops and destroying entire *harvests*. Suddenly, a bit of shading and additional protection from solar panels doesn't seem to be such a bad idea after all. What used to be a conflict might actually be a solution.

MANY WAYS OF SHARING THE SUN

Agrivoltaic systems come in a *surprisingly* wide variety of shapes and sizes. Some take the *initial* idea of mounting the panels high and wide to the extreme so that even *combine harvesters* can pass under them, which makes them

suitable for *grain* fields. The necessary *support structures*, however, are massive and costly and make the fields look like industrial *plants*. Much more often, raised agrivoltaic systems can be found in *orchards*, berry and vegetable farms, where the supports are much lower and the *shielding* of the panels can *augment* or even replace other protective *measures* like *nettings*.

Another method is to place the solar panels on the ground as usual but with a larger spacing between the *rows* so that crops can be grown in between. Naturally, this configuration is only suitable for smaller crops such as *lettuce* or *herbs*, which don't *cast* a shadow on the panels. In a wider sense, traditional solar farms where the grass between the rows is *held in check* by regular visits of a herd of sheep may also be *considered* a form of agrivoltaics.

In most of these systems the panels are permanently adjusted to a certain *angle* but some are *equipped* with single-

or dual-axis *tracking*. Here the photovoltaic modules either follow the sun horizontally *according to elevation*, vertically according to its azimuth or both. Although more costly, tracking generates a higher solar power *yield* but often creates areas of permanent shadow unsuitable for growing. On the other hand, a tracking system may allow the panels to be moved out of the way for *passing* agricultural vehicles during field work or to form a sort of protective roof during extreme weather events.

Since agrivoltaic systems are specifically designed to 'share' the sun, the rows of their solar panels do not necessarily run in the classic east-west orientation as this may result in permanently shadowed areas underneath them. Setting the rows up at a slight angle results in a more *homogeneous* lighting of the crops with only minimal loss *with regard to* power generation. Another option is to have double-rows run from north to south with the panels slightly *tilted* >>>

according to	gemäß, je nach
advantageous // ,ædvən'teɪdʒəs	vorteilhaft, günstig
angle	Winkel
anticipate, to // æn'tɪsɪpeɪt	voraussehen, erwarten
arduous // 'ɑːdʒuəs	mühsam, beschwerlich
argue, to	darlegen, behaupten
augment, to	ergänzen, erweitern
beneficial // ,benɪ'fɪʃl	vorteilhaft, nützlich
cast, to	hier: werfen
combine harvester // 'kɒmbaɪn 'hɑːvɪstə	Mähdrescher
consider, to	betrachten, erachten
crop	Kulturpflanze, Feldfrucht
dry spell	Trockenperiode
either // 'aɪðə	entweder
elevate, to	anheben, erhöhen
elevation	Höhe
equip, to	ausstatten, ausrüsten
founder	Gründer, Gründerin
gain traction, to // gem 'trækʃn	an Zugkraft/Fahrt gewinnen
grain	Getreide, Korn
hail	Hagel
hamper, to // 'hæmpə	behindern, beeinträchtigen
harvest	Ernte, Lese
harvest, to	ernten, einbringen
herb // hɜːb	Kraut, Gewürz
hold in check, to (held, held)	in Schach halten
homogeneous // ,hɒmə'dʒiːniəs	gleichmäßig, homogen
however	jedoch, allerdings
initial // ɪ'nɪʃl	ursprünglich, anfänglich
instead of	anstelle von, statt
late	hier: verstorben
lettuce // 'letɪs	Kopfsalat
measure	Maßnahme
negligible // 'neglɪdʒəbl	vernachlässigbar, unwesentlich
net gain	Nettogewinn
netting	Netz
orchard // 'ɔːtʃəd	Obstplantage
pass, to	vorbeifahren, vorbeikommen
plant	Fabrik, Werk

ponder, to	nachdenken, grübeln
require, to	erfordern, benötigen
row	Reihe
shielding	Abschirmung
solution // sə'ljuːʃn	Lösung
source	Quelle, Ursprung
space, to	verteilen, mit Abstand anordnen
support structure	Stütz-, Unterkonstruktionen
surprisingly	überraschend, erstaunlich
switch, to	umschalten, wechseln
tilt, to	neigen, kippen
tracking	Nachführung
usage	Nutzung, Verwendung
vegetable // 'vedʒtəbl	Gemüse
wheat // wi:t	Weizen
with regard to	in Bezug auf
yield // jiːld	Ertrag, Ausbeute, Gewinn

Depending on the set-up, agrivoltaics is suitable for most crops – be it grain (top left), apples (below), vegetables or grapes.



< PHOTO: FRAUNHOFER ISE >



< PHOTO: AGROSOLAR >

Tall support structures provide even shading and access for large vehicles but they are expensive and make the fields look like industrial plants.

towards the rising and setting sun. While this *alignment* generally maximizes the movement of shadow over the course of the day it is *vital* to leave enough space for the sun to pass through. It is therefore often used in combination with narrow strips of solar panels, glass panels with widely spaced solar cells or semi-transparent solar cells.

THE TWO FACES OF PHOTOVOLTAICS

The most unusual setup, however, is *bifacial* vertical solar panels which, at first *glance*, seem to *contradict* our general *notion* of how solar panels should be ideally oriented. For one, these panels are, as the name *suggests*, mounted vertically, which, when placed side by side, gives them the *appearance* of a *fence*. Even worse though, these ‘fences’ usually run north to south so that at *noon* they don’t get any direct sunlight at all. While this might *benefit* the crops in between, how can this be any good for power generation?

The trick is that the cells used for these panels are bifacial, meaning they can produce power when *illuminated* from the front and from the rear. Bifacial solar cells have their contact *grids exposed* on both sides and are engineered to generate a *photocurrent* from either side. They are usually sandwiched between two glass plates to form a solar panel. While the technology is almost as old as the solar cell itself, bifacials have only recently started to *gain* in popularity. *Due to* sinking production costs they are now *increasingly* used in classic solar arrays on *rooftops* or fields, where they can produce extra power from light reflected onto the rear of the panels. Still slightly more expensive to manufacture, bifacial solar cells

are nonetheless becoming more and more the norm and may soon replace monofacial cells entirely.

Placed vertically with their silicon facing towards the rising and setting sun, bifacial cells naturally have an energy generation profile with *distinct peaks* in the morning and afternoon and a *steep drop* during noon. *Notwithstanding* this, and somewhat *counterintuitive*, the total *wattage* per day is slightly higher than that of a conventional installation with a single midday peak. Even more so, bifacial cells generate power when it’s most needed, namely during the times when we get up and *settle in* for the day.

Without the need for tall, *overarching* supports and no overhead *obstruction*, bifacial vertical solar panels are a good choice for agrivoltaic projects, which require constant *access* with large agricultural machinery such as, for example, grain farming. The *increased* shading during the lower sun in spring and autumn, however, can *impact* the crop yield significantly.

MORE THAN APPLES AND AMPS

Despite all these different *approaches* and the wide *range* of available technical solutions the dual use of land for photosynthesis and photovoltaics may not be *suitable* for all kinds of crop farming. Then again, the worldwide capacity of installed agrivoltaics is *estimated* to be over 14 gigawatt peak – with 12 gigawatt peak in China alone – and rapidly growing.

Often it’s not so much the need to use the land for both solar and seeds, but the added benefits which drive the *decision* for agrivoltaics – *despite* the extra costs. In *semi-arid* regions, for example, the extra shading of overhead moun-

ted panels offers protection from harsh sunlight and keeps more *moisture* in the *soil*, which may allow the cultivation of crops in the first place. As an added bonus the generated electricity can be used on site for *irrigation*.

A bit closer to home, several research projects in Germany and Europe have proven the potential of agrivoltaics, especially in connection with specialized crops from *viti-culture* to fruit and vegetable growing. Crops like apples, *grapes* or berries are highly sensitive to extreme weather and represent a high *value* per area. Here the panels can

often replace plastic netting as protection against hail, strong winds or too much sun. More closely spaced, the elevated panels may even form a sort of “open *greenhouse*” generating a microclimate beneficial not only for the crops: Water *evaporated* by the plants cools the panels, which in turn increases their yield, too.

Another reason we might see more agrivoltaic systems in the near future is their *ability* to provide large *amounts* of electric power ‘on site’. Fields aren’t usually connected to the grid, which can be a problem if farmers want to sell their >>>

<i>ability</i>	Fähigkeit, Vermögen
<i>access</i>	Zugang, Zufahrt
<i>alignment</i>	Ausrichtung, Orientierung
<i>amount</i>	Menge
<i>appearance</i>	Aussehen, Erscheinung
<i>approach</i> // ə'prəʊtʃ	Ansatz, Herangehensweise
<i>benefit, to</i>	nutzen, zugutekommen
<i>bifacial</i> // ,bɪ'feɪʃl	beidseitig
<i>contradict, to</i>	widersprechen, im Gegensatz stehen
<i>counterintuitive</i> // ,kaʊntərɪn'tju:ɪtɪv	unlogisch, kontraintuitiv
<i>decision</i> // dɪ'sɪʒn	Entscheidung
<i>despite</i>	trotz, ungeachtet
<i>distinct</i>	deutlich, ausgeprägt
<i>drop</i>	Abfall, Rückgang
<i>due to</i>	aufgrund von, wegen
<i>estimate, to</i>	schätzen, veranschlagen
<i>evaporate, to</i>	verdunsten
<i>expose, to</i>	aussetzen, freilegen
<i>fence</i>	Zaun, Gatter
<i>gain, to</i>	gewinnen, zulegen
<i>glance</i>	Blick
<i>grape</i>	Traube
<i>greenhouse</i>	Gewächshaus
<i>grid</i>	Gitter, auch: Stromnetz

<i>illuminate, to</i>	beleuchten
<i>impact, to</i>	beeinflussen, beeinträchtigen
<i>increase, to</i> // ɪn'kri:s	steigern, erhöhen
<i>increasingly</i>	zunehmend
<i>irrigation</i> // ,ɪrɪ'geɪʃn	Bewässerung
<i>moisture</i> // 'mɔɪstʃə	Feuchtigkeit
<i>noon</i>	Mittag
<i>notion</i> // 'nəʊʃn	Vorstellung, Idee
<i>notwithstanding</i> // ,nɒtwɪð'stændɪŋ	trotz, ungeachtet
<i>obstruction</i> // əb'strʌkʃn	Behinderung, Hindernis
<i>overarch, to</i> // ,əʊvər'ɑ:tʃ	überspannen
<i>peak</i>	Spitze, Höhepunkt
<i>photocurrent</i>	Photostrom
<i>range</i> // reɪndʒ	Reihe, Spektrum, Vielfalt, Palette
<i>rooftop</i>	Dach, Hausdach
<i>semi-arid</i>	halbtrocken
<i>settle in, to</i>	es sich gemütlich machen
<i>soil</i>	Boden, Erde, Erdreich
<i>steep</i>	steil, abschüssig
<i>suggest, to</i> // sə'dʒest	nahelegen, suggerieren
<i>suitable</i>	geeignet, zweckmäßig
<i>value</i>	Wert, Wertschöpfung
<i>vital</i> // 'vaɪl	unerlässlich, wichtig
<i>viticulture</i> // 'vɪtɪkʌltʃə	Weinbau
<i>wattage</i>	elektrische Leistung, Wattzahl



Closely spaced rows of solar panels offer additional protection from hail or strong winds and create a microclimate that's beneficial for the crop as well as for the solar cells.

electricity. The other way round, an *outlet* at the side of the field may allow farmers to run machinery, which *previously* would have required a Diesel generator or simply would have been impossible – think *refrigeration* or large pumps. Besides, we are currently moving away from fossil fuels towards electric mobility, a transformation which will affect farmers, too. The first electric tractors are already available and battery-powered combine harvesters are in development. A *charging station* between the *barley* and the *rye* could save a time-consuming trip back to the *barn* for *recharging*.

Who knows, with more and more farmers adopting agrivoltaics, in the future we might stop at the *farm shop* not only for carrots, potatoes or *asparagus* but also to recharge our electric vehicles. <<< Matthias Meier >>>

<i>asparagus</i> // əˈspærəgəs	Spargel
<i>barley</i>	Gerste
<i>barn</i>	Scheune
<i>charging station</i>	Ladestation
<i>farm shop</i>	Hofladen
<i>outlet</i>	hier: Steckdose
<i>previously</i>	bisher, zuvor, vorher
<i>recharge</i> , to // ˌriːˈtʃɑːdʒ	aufladen
<i>refrigeration</i> // ˌrɪˌfrɪdʒəˈreɪʃn	Kühlung, Kühltechnik
<i>rye</i> // raɪ	Roggen

www.ise.fraunhofer.de/de/geschaeftsfelder/solkraftwerke-und-integrierte-photovoltaik/integrierte-photovoltaik.html

Das Fraunhofer ISE ist einer der Pioniere im Bereich Agri-Photovoltaik und betreut mehrere Forschungsprojekte.

www.ise.fraunhofer.de/content/dam/ise/de/documents/publications/studies/APV-Leitfaden.pdf

Sehr ausführliche Broschüre über Agri-Photovoltaik, die die Inspiration zu diesem Artikel war.

www.dgs.de/fileadmin/newsletter/2019/SE_3-81_Kartoffeln_unter_dem_Kollektor.pdf

Artikel von 1981 über die damals neue Idee von Goetzberger und Zastrow Felder für Landwirtschaft und Solarfarmen gleichzeitig zu nutzen.

<https://next2sun.com>

Next2Sun baut Solaranlagen mit senkrechter Aufstellung und bifazialen Zellen.

www.agrosolareurope.de

Agrosolar baut Agri-PV Anlagen in fast allen im Artikel beschriebenen Ausführungen.

www.landschaftenergie.bayern/beratung/sonnenenergie/agri-photovoltaik/branchenverzeichnis

Ausführliches Branchenverzeichnis für alle Dienstleistungen rund um die Agri-Photovoltaik.

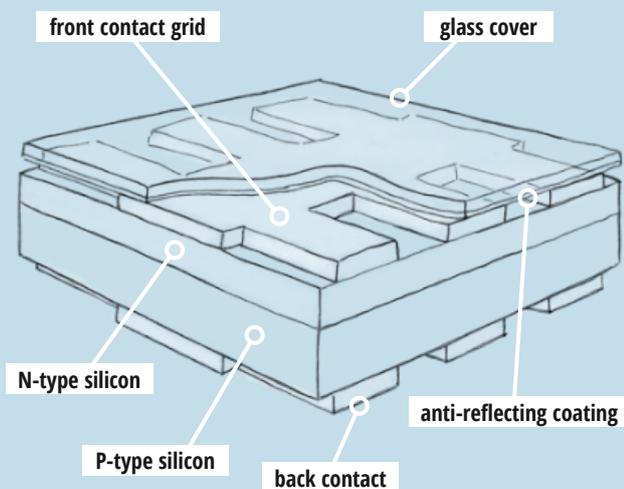


Links, Vokabeln & mehr unter

www.inchbyinch.de/inch41/agrivoltaics

TECH EXTRAS

PICTORIAL SOLAR CELL



MINI DICTIONARY

AGRICULTURAL MACHINERY

<i>agricultural machinery</i>	Landmaschinen
<i>articulated drawbar trailer</i>	Gelenkdeichselanhänger
<i>bale loading and transport trailer</i>	Ballenlade- und transportwagen
<i>bale wrapper</i>	Ballenwickelgerät
<i>combine (harvester)</i>	Mähdrescher
<i>combine header</i>	Mähdreschervorsatz
<i>crawler tractor</i>	Raupentraktor
<i>cultivator</i>	Grubber
<i>cutter unit</i>	Schneidwerk
<i>direct seed drill</i>	Direktsaatmaschine
<i>dumper trailer</i>	Kippmuldenanhänger
<i>harrow</i>	Egge
<i>planter</i>	Pflanzermaschine
<i>plough</i>	Pflug
<i>potato lifter</i>	Kartoffelroder
<i>precision seed drill</i>	Einzelkornsämaschine
<i>roller</i>	Walze
<i>round baler</i>	Rundballenpresse
<i>straw chopper</i>	Strohhäcksler
<i>subsoiler</i>	Tiefenlockerer
<i>sugar beet lifter</i>	Zuckerrübenroder
<i>swap body trailer</i>	Wechselaufbauanhänger
<i>tank trailer</i>	Tankanhänger
<i>trailer</i>	Anhänger
<i>wheeled tractor</i>	Radtraktor

Modellraketenbau ist so alt wie die Raumfahrt selbst. Heute machen Bausätze und fertige Treibsätze das Hobby sicher und zugänglich. Der Start von der Wiese ist damit alles andere als eine „Raketenwissenschaft“.

There is probably no other modelling hobby which actually *predates* the thing it's modelling. Rocket pioneers like Robert Goddard or Wernher von Braun first built model-sized rockets before they pushed rocket science to, literally, new heights. The rocket *craze* caused by the *launch* of Sputnik and the *ensuing* space race then inspired many enthusiasts to build model rockets of their own – often with varying results including serious *injuries* and burns. It's rocket science after all.



< PHOTO: JOE SCHNEID/WIKIMEDIA COMMONS >

The science became a safe hobby at the end of the 1950s. In the US, pyrotechnician Orville Carlisle had developed a small, safe rocket engine which Vernon Estes, a local fireworks maker, later started to mass-produce. Today, Estes is the market leader for model rockets having produced several hundred million tiny rocket engines. Back in 1957, Carlisle also *founded* the National Association of Rocketry, now the oldest and largest space modelling organization in the world.

Strict standards and mass-produced engines make model rockets a surprisingly safe hobby. In Germany, anyone aged 14 or older can *launch* small rockets up to an *altitude* of 120 meters without a license; however, *joining* a club and using its *dedicated* launch areas is highly recommended**.

Unlike their real-life *counterparts*, model rockets are a relatively simple affair: They consist of a tube-shaped body with a set of *fins*. The *nose cone* usually *pops* out to release a little *parachute*. Rocket motors are *inserted* like a *cartridge* and those for hobbyists can hold up to 20 grams of *propellant*, which is good for burning times *ranging* from less than a second up to six seconds. For anything more powerful, *budding rocketeers* will need a license and a launch *permit*.

Once everything is set, the model rocket is *slid* in a 'launch tower', usually a long *rod* or rail, which provides stabilisation until the aerodynamic forces acting on the fins take over. At T minus zero, lift-off is initiated via a *fuse* or electrically. After the propellant is burnt up a *delay charge* is *ignited* to allow the rocket to reach its *apogee* before a small *ejection charge* is fired, which ejects the rocket motor's end cap, the nose cone and the parachute.

To make rocket modelling more interesting than just a short *swish* and a long *jog* to *retrieve* the rocket, young rocket scientists sometimes add cameras or flight trackers

which record speed and altitude. Or they “*commit* themselves to *achieving* the goal of launching an egg and returning it safely to the Earth.”

More *experienced* rocketeers often experiment with *multi-stage* rockets, engine clusters or try to replicate historic or *current* rocket designs – some even manage to pull off a *propulsive* landing SpaceX-style. That's where the fun, and the rocket science, begins. <<< Matthias Meier >>>

www.raketenmodellbau.org/links

Diese Linkliste des Raketenmodellbau-Portals, u.a. mit Links zu Herstellern und Clubs, hilft beim Einstieg ins Hobby.

www.nar.org

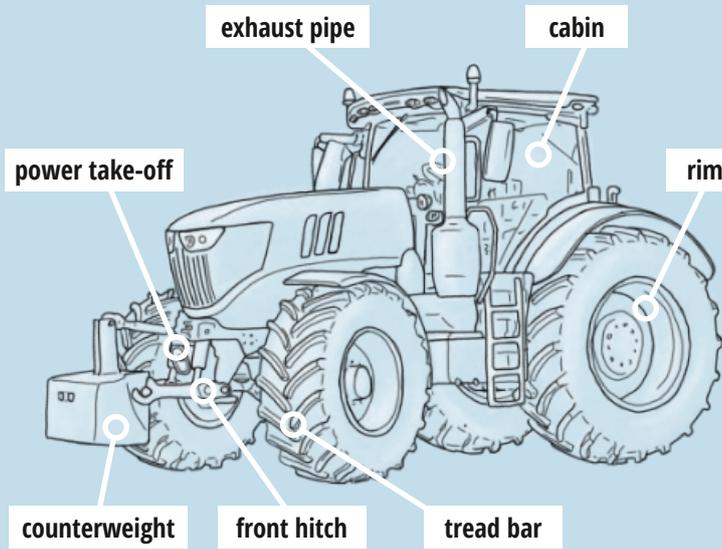
Die amerikanische National Association of Rocketry ist die älteste, größte und aktivste Modellraketenvereinigung weltweit.

** Die genaue Gesetzeslage zum Starten von Modellraketen ist natürlich ein bisschen komplizierter. Einen ersten Überblick gibt's hier:

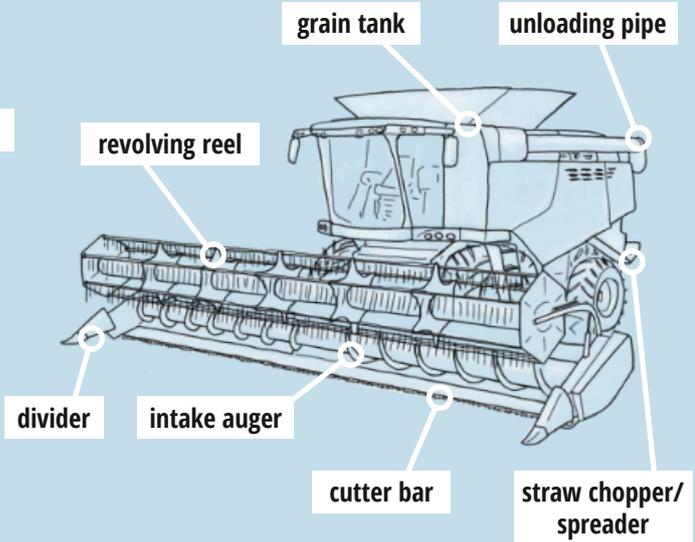
www.ramog.de/content/gesetzliche-bestimmungen

<i>achieve, to</i> // ə'tʃi:v	erreichen, erzielen
<i>altitude</i>	(Flug-) Höhe
<i>apogee</i> // 'æpədʒi:	Gipfelpunkt, Apogäum
<i>budding</i>	angehend
<i>cartridge</i> // 'kɑ:trɪdʒ	Patrone, Kartusche
<i>commit, to</i>	verpflichten, sich binden
<i>counterpart</i>	Gegenstück
<i>craze</i>	Welle, Wahn
<i>current</i> // 'kʌrənt	aktuell, gegenwärtig
<i>dedicated</i>	geeignet, reserviert
<i>delay charge</i> // dɪ'leɪ tʃɑ:dʒ	Verzögerungsladung
<i>ejection charge</i> // ɪ'dʒekʃn tʃɑ:dʒ	Auswurfladung
<i>ensuing</i> // m'sju:ɪŋ	anschließend, folgend
<i>experienced</i>	erfahren, versiert
<i>fin</i>	Seitenleitwerk, Flosse
<i>found, to</i>	gründen, etablieren
<i>fuse</i>	Züandschnur
<i>goal</i> // gəʊl	Ziel
<i>ignite, to</i> // ɪg'naɪt	zünden, anzünden
<i>injury</i> // 'ɪndʒəri	Verletzung
<i>insert, to</i>	einfügen, einstecken
<i>jog</i>	Lauf, Trab
<i>join, to</i>	beitreten, sich anschließen
<i>launch</i> // lɔ:ntʃ	Start
<i>launch, to</i> // lɔ:ntʃ	starten
<i>multi-stage</i> // 'mʌltɪsteɪdʒ	mehrstufig
<i>nose cone</i>	Raketenspitze
<i>parachute</i> // 'pærəʃu:t	Fallschirm
<i>permit</i> // 'pɜ:mɪt	Genehmigung, Erlaubnis
<i>pop, to</i>	knallen, platzen
<i>predate, to</i> // ,pri:'deɪt	älter sein als, vorausgehen
<i>propellant</i>	Treibstoff
<i>propulsive</i>	hier etwa: m. laufendem Triebwerk
<i>range, to</i> // reɪndʒ	reichen, sich bewegen
<i>retrieve, to</i>	zurückholen, wiederfinden
<i>rocketeer</i>	etwa: Raketenflieger
<i>rod</i>	Stab, Stange
<i>slide, to</i> (slid, slid)	schieben
<i>swish</i>	Zischen

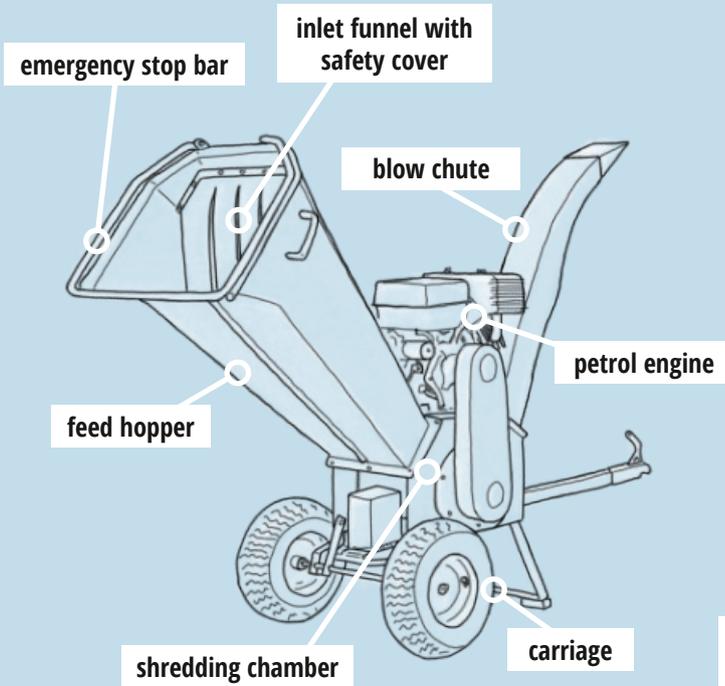
FARMING & GARDENING EQUIPMENT



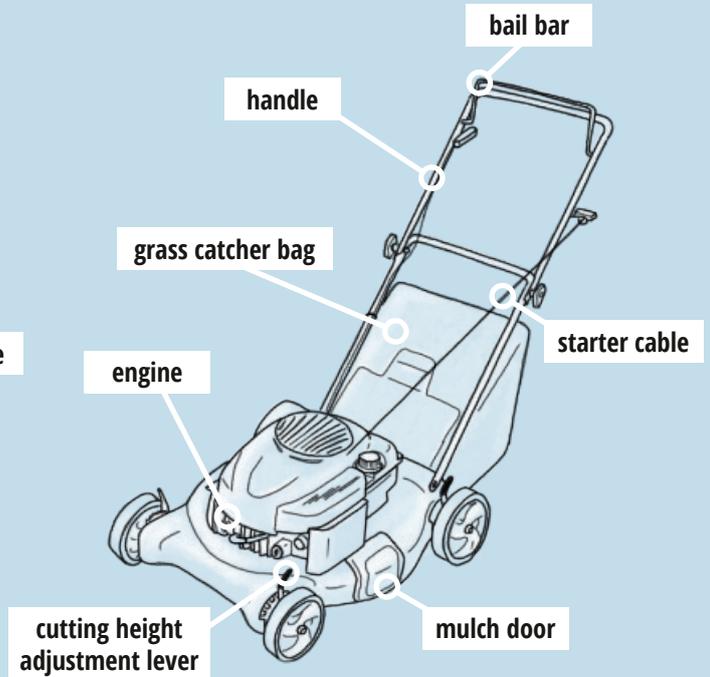
TRACTOR



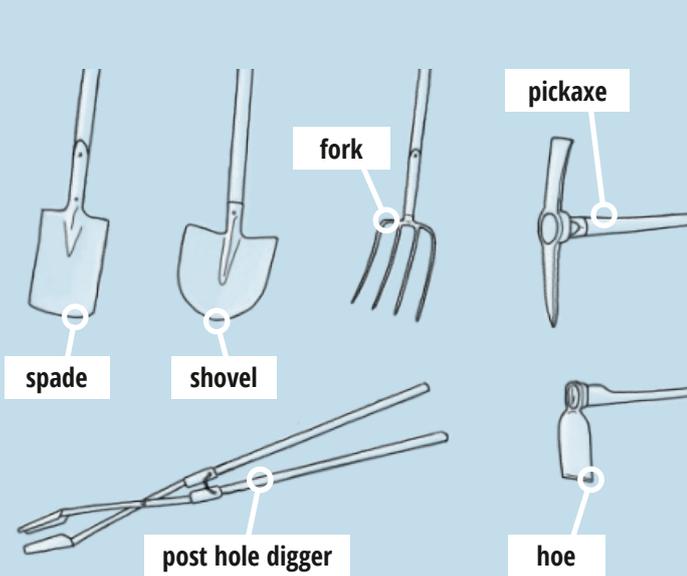
COMBINE HARVESTER



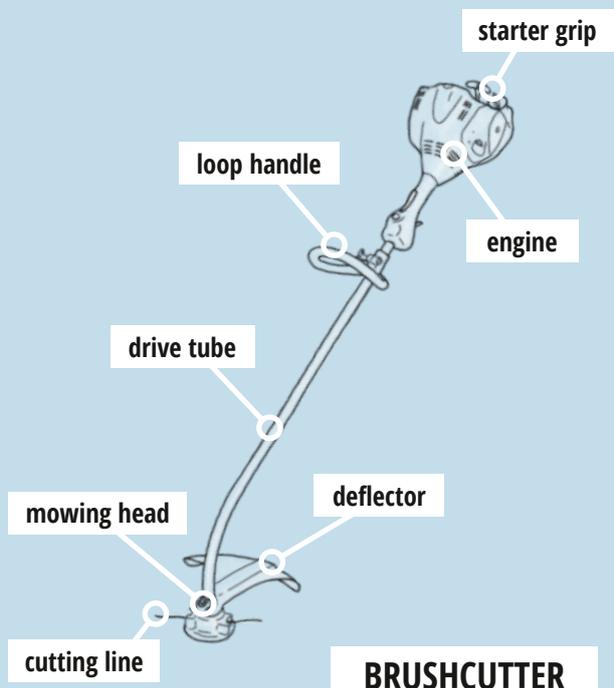
CHIPPER SHREDDER



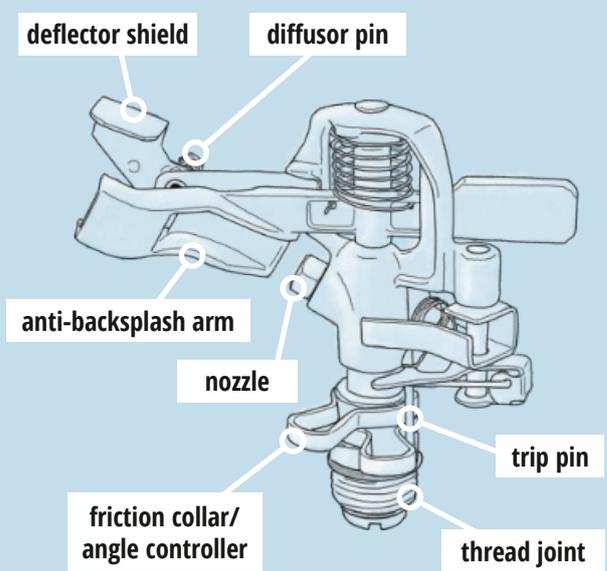
LAWN MOWER



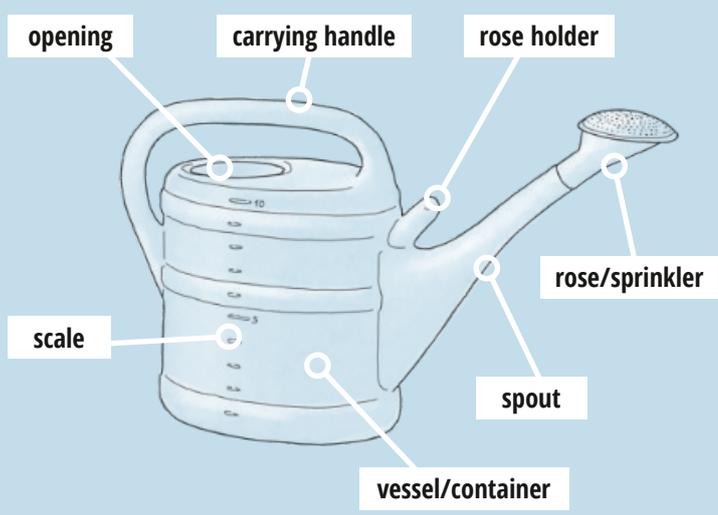
DIGGING TOOLS



BRUSHCUTTER



IMPULSE/IMPACT SPRINKLER



WATERING CAN

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<i>abrasive paper</i>	Schleifpapier
<i>accelerator</i>	Beschleuniger
<i>acid</i>	Säure
<i>acrylic resin lacquer</i>	Acrylharzlack
<i>adamantine coating</i>	diamantartige Schicht
<i>adhesive</i>	Klebstoff
<i>adhesive primer</i>	Haftprimer
<i>alkaline galvanizing</i>	alkalisch Verzinken
<i>anneal, to</i>	glühen
<i>anode</i>	Anode
<i>anodic coating</i>	Anodisieren
<i>anodize, to</i>	eloxieren
<i>anti-rusting compound</i>	Rostschutzmittel
<i>antifriction coating</i>	Gleitbelag
<i>arc spraying</i>	Lichtbogenspritzen
<i>atomize, to</i>	zerstäuben
<i>baking lacquer</i>	Einbrennlack
<i>ball finishing</i>	Kugelpolieren
<i>bath</i>	Bad
<i>black galvanizing</i>	Schwarzverzinken
<i>blast, to</i>	strahlen
<i>blasting agent</i>	Strahlmittel
<i>boron treating</i>	Borieren
<i>Brinell hardness</i>	Brinellhärte
<i>brushing, to</i>	bürsten
<i>burnish, to</i>	brünieren
<i>cadmium-plating</i>	Cadmieren
<i>carbonitriding</i>	Carbonitrieren
<i>case hardening</i>	Einsatzhärten
<i>catalyzer</i>	Katalysator
<i>cataphoretic coating</i>	Kataphoretische Beschichtung
<i>cathode</i>	Kathode
<i>cathodic sputtering</i>	Kathodenzerstäuben
<i>caustic</i>	Lauge
<i>ceramic</i>	Keramik
<i>chamber furnace</i>	Kammerofen
<i>chromatizing</i>	Chromatieren
<i>chromium</i>	Chrom
<i>circulating air dryer</i>	Umlufttrocknungsanlage
<i>clean, to</i>	reinigen
<i>cleanroom technology</i>	Reinraumtechnik
<i>clear lacquer</i>	Klarlack
<i>coat thickness testing</i>	Schichtdickenprüfung
<i>coat, to</i>	beschichten
<i>colour shade card</i>	Farbtonkarte
<i>continuous dryer</i>	Durchlauf Trockner
<i>corrosion</i>	Korrosion
<i>corrosion protection</i>	Korrosionsschutz
<i>decoat, to</i>	entschichten
<i>degrease, to</i>	entfetten
<i>diffusion coating</i>	Diffusionsverfahren
<i>dip, to</i>	tauchen
<i>dipping lacquer</i>	Tauchlack
<i>dispersion coating</i>	Dispersionsschicht
<i>drum</i>	Trommel
<i>dry ice blasting</i>	Trockeneisstrahlen

<i>dry-film lubrication layer</i>	Trockenschmierschicht
<i>dry, to</i>	trocknen
<i>drying kiln</i>	Trockenofen
<i>dust separator</i>	Staubabscheider
<i>dye</i>	Farbstoff
<i>eddy-jet system</i>	Wirbelstrahlanlage
<i>egg-shell lacquer</i>	Schleiflack
<i>electrode</i>	Elektrode
<i>electrodialysis</i>	Elektrodialyse
<i>electrolysis cell</i>	Elektrolysezelle
<i>electrolyte</i>	Elektrolyt
<i>electrometallization of plastics</i>	Galvanisieren von Kunststoffen
<i>electron-beam</i>	Elektronenstrahl
<i>electrophoresis</i>	Elektrophorese
<i>electroplate, to</i>	galvanisieren
<i>electropolishing</i>	Elektropolieren
<i>electrostatic</i>	elektrostatisch
<i>enamel</i>	Email
<i>epoxy resin</i>	Epoxidharz
<i>etch, to</i>	ätzen
<i>evaporator</i>	Verdampfer
<i>filler</i>	Spachtelmasse
<i>fine-dust measuring</i>	Staubmessung
<i>finish polishing</i>	Glänzen
<i>finishing</i>	Veredelung
<i>flame hardening</i>	Flammhärten
<i>flame spraying</i>	Flammspritzen
<i>flame-hardening</i>	Brennhärten
<i>flaming</i>	Beflammung
<i>flow coating plant</i>	Flutbeschichtungsanlage
<i>furnace</i>	Ofen
<i>fusion compound coating</i>	Schmelzverbundbeschichten
<i>glaze</i>	Glasur
<i>gold plating</i>	Vergolden
<i>grind, to</i>	schleifen
<i>grinding tool</i>	Schleifkörper
<i>hammer effect enamel</i>	Hammerschlageffektlack
<i>hard-metal coating</i>	Hartmetallbeschichtung
<i>harden, to</i>	härten
<i>hardness testing</i>	Härteprüfung
<i>heat treatment</i>	Wärmebehandlung
<i>hot dip coating</i>	Schmelztauchen
<i>hot-dip galvanizing</i>	Feuerverzinken
<i>hydrophilic</i>	hydrophil
<i>impregnate, to</i>	imprägnieren
<i>induction hardening</i>	Induktionshärten
<i>induction heating</i>	Induktionserwärmung
<i>ion beam technology</i>	Ionenstrahltechnik
<i>lacquer</i>	Lack
<i>lap, to</i>	läppen
<i>laser spraying plant</i>	Laserspritzanlage
<i>laser sputtering</i>	Lasersputtern
<i>layer</i>	Schicht
<i>liquid coating plant</i>	Nassbeschichtungsanlage
<i>malleablizing</i>	Tempern
<i>metal spraying</i>	Metallspritzen

abrasive paper, bath, ceramic, decoat, electroplate, flame hardening, grinding tool, heat treatment, impregnate, lacquer, malleablizing, nitriding, orbital sander, plasma spraying, quench, reflective coating, sandblasting, tin, UV dryer, varnish, wire spraying, zinc – **200+ surface technology terms**

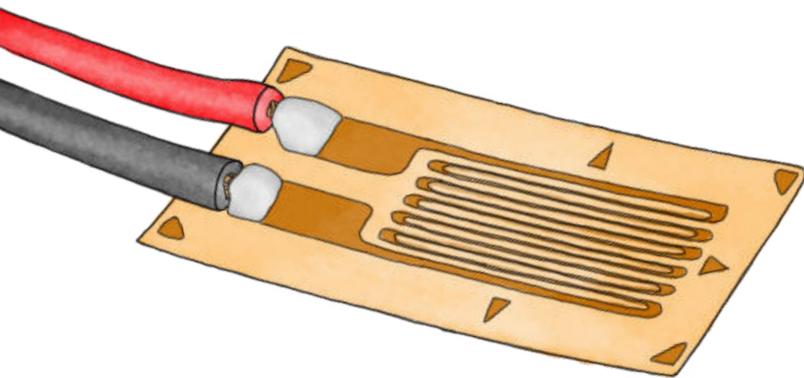
metal spraying of zinc	Spritzverzinken
metallize, to	metallisieren
mixing nozzle	Mischdüse
nano-technology	Nanotechnik
neutralization agent	Neutralisationsmittel
Nickel	Nickel
nitriding	Nitrieren
nitrogen removal of coatings	Stickstoffentschichtung
non-destructive testing	zerstörungsfreie Prüfung
nozzle	Düse
orbital sander	Schwingschleifer
oxidation agent	Oxidationsmittel
paint	Farbe
paint coagulating equipment	Lackkoagulieranlage
paint measuring device	Farbmessgerät
paint stripping agent	Abbeizmittel
passivate, to	passivieren
phenolic resin lacquer	Phenolharzlack
phosphatizing	Phosphatierung
pickle, to	beizen
pickling liquor	Beizbad
pigment	Pigment
plasma CVD plant	Plasma-CVD-Anlage
plasma diffusion	Plasmadiffusion
plasma spraying	Plasmaspritzen
plastic coating	Kunststoffbeschichten
plate, to	plattieren
polish, to	polieren
polishing agent	Schleifmittel
polishing paste	Polierpaste
polyester resin	Polyesterharz
powder	Pulver
powder coating	Pulverbeschichten
powder spraying equipment	Pulversprüngerät
powder varnish	Pulverlack
pretreatment	Vorbehandlung
primer	Grundierung
PVD coating	PVD-Beschichten
quench, to	abschrecken
radiation dryer	Strahlungstrockner
recovery installation	Rückgewinnungsanlage
red lead	Bleimennige
reflective coating	Verspiegelung
relief printing	Prägen
remelt hardening	Umschmelzhärten
rotary hearth furnace	Drehherdofen
rust removing agent	Rostentfernungsmittel
saltspray testing device	Salzsprühprüfgerät
sandblasting	Sandstrahlen
scratch resistant	kratzfest
seal, to	versiegeln
Sendzimir hot-dip galvanizing installation	Sendzimir-Verzinkungsanlage
shot peening	Kugelstrahlen
silicone-free	silikonfrei
smooth, to	glätten

solvent	Lösemittel
spray gun	Spritzpistole
spray, to	spritzen
spraying booth	Sprühkabine
spraying can	Sprühdose
spraying plant	Farbspritzanlage
spraying stencil	Spritzschablone
sputter coating	Sputterschicht
stainless	nichtrostend
stencil	Schablone
stirrer	Rührwerk
stripping	Entmetallisieren
surface	Oberfläche
surface coating	Oberflächenbeschichtung
surface measuring equipment	Oberflächenmessgerät
surface technology	Oberflächentechnik
suspension gear	Gehänge
synthetic resin lacquer	Kunstharzlack
test jar	Messbecher
thermal spraying	thermischen Spritzen
thin film coating	Dünnschichtbeschichtung
tin	Zinn
tumbler coating plants	Trommelbeschichtungsanlage
tunnel furnace	Tunnelofen
two-component lacquer	Zweikomponentenlack
ultrasonic cleaning	Ultraschallreinigen
ultrasonic varnish removal plant	Ultraschall-Entlackungsanlage
UV dryer	UV-Trockner
vacuum metallizing	Vakuumaufdampfen
vaporize, to	aufdampfen
varnish	Firnis
varnish removal	Entlacken
varnish testing equipment	Lackprüfgerät
varnishing plant	Lackieranlage
varnishing trestle	Lackiergestell
viscometer	Viskosimeter
visual testing	Sichtkontrolle
washing plant	Waschanlage
water jet blasting	Wasserstrahlen
water lacquer	Wasserlack
water treatment	Wasseraufbereitung
wear resisting coating	Verschleißschutzschicht
weld plating plant	Schweißplattieranlage
wet varnishing	Nasslackieren
wire spraying	Drahtflammspritzen
zinc	Zink
zinc coating	Verzinken

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



SENSORS & TRANSDUCERS



Sensors and *transducers* are our eyes and ears into the world. They allow us to measure, quantify and compare physical parameters such as pressure, temperature, *voltage* and others. The *distinction* between sensor and transducer is difficult as the *terms* are often used *interchangeably*, especially concerning electronic measurements, and the definitions vary wildly.

A sensor is generally *regarded* as a *device* that can sense or detect a physical quantity and generate a measurable output in the same or a different physical quantity which is a function of the input's amplitude. A glass thermometer, for example, is a sensor since the alcohol or *quicksilver* reacts to temperature variations by changing its volume.

A transducer, on the other hand, is a device or component that converts energy from one form into another. This energy might be mechanical or chemical but in the context of electronics and signal processing transducers are typically used to convert physical phenomena into electrical signals – or *vice versa*. Devices which convert electrical energy into, say, mechanical energy, such as speakers or electric motors, are commonly *referred to* as actuators.

Electronic devices capable of measuring physical parameters so that they can be processed by electronics or computers are usually a combination of both sensor and transducer, with a few *exceptions* such as solar cells or *thermocouples*, i.e. sensors which directly generate electric energy. To avoid any further confusion, the devices used for sensing and detecting in the industry are in the following referred to as transducers. The large number of physical parameters and the many ways to convert them into an electrical signal creates an almost *infinite* number of transducers. Here are some examples for the most *common* parameters.

TEMPERATURE

The three most widespread transducers for translating temperature phenomena into a measurable signal are thermocouple, *resistance temperature detectors* (RTDs), and thermistor.

Thermocouples rely on the Seebeck effect. When two wires made of different metals are connected and heated at one end, a thermoelectric *circuit* is formed, which creates a measurable voltage differential at the “cold” end of the two wires.

Resistance temperature detectors and thermistors are active measurement devices that operate by changing their *resistance according to the ambient* temperature. RTDs are constructed by encapsulating a thin metal winding in a glass or ceramic *core* or by layering a thin layer of metal between *insulating* materials. Thermistors, on the other hand, consist of a metal oxide *semiconductor* pressed into a small *bead*, disk or wafer *coated* with epoxy or glass. Thermistors provide a high sensitivity and are ideal for measuring smaller temperature changes. Unlike an RTD, a thermistor is typically a negative temperature coefficient device, which means its resistance *decreases* with an *increase* in temperature

FORCE

Forces and *related* parameters such as *strain*, *torque*, pressure or *acceleration* are often measured with *strain gauges*, capacitive or piezoelectric pressure transducers.

A strain gauge commonly consists of a very fine wire or metallic foil arranged in a zig-zag *pattern* of parallel lines. The pattern is *bonded* to a thin backing, which is *attached* directly to the test *specimen*. Since the *conductance* is dependent on the length as well as the cross-section area of a *conductor*, any deformation of the strain gauge results in a change of its electric resistance. These changes, however, are very small. As a consequence, strain gauges are generally configured in a Wheatstone bridge circuit, a network of four *resistive* arms with an *excitation* voltage that is applied across the bridge.

Forces can also be measured with variable capacitance pressure transducers. They are composed of two capacitive plates, a *diaphragm* and an electrode, with a certain distance between them. A change in pressure will widen or narrow the *gap* between the two plates, which varies the *capacitance*. This change in capacitance is then converted into a usable signal.

Piezoelectric transducers rely on the electrical *properties* of quartz crystals. These crystals generate an electric *charge* in response to applied mechanical *stress*. Electrodes transfer the charge from the crystals to an *amplifier* built into the sensor.

POSITION

A large variety of transducers based on different principles is available for registering *spatial* parameters such as presence, length or distance, *angles*, position or *displacement*, volumes or levels. Here are just a few of them:

One of the simplest is certainly the potentiometer. It acts as a voltage *divider* or variable *resistor* by rotating or *sliding* a con-

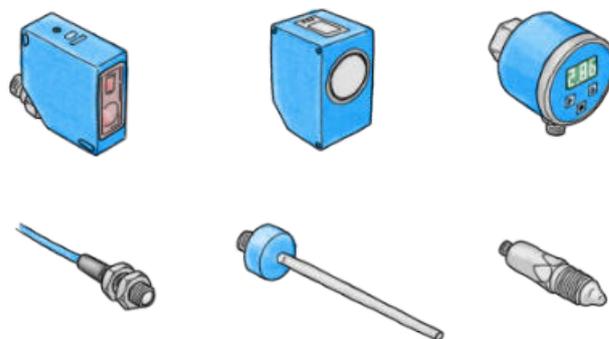
Sensoren und Wandler gehören mit zu den wichtigsten Baugruppen, denn sie machen die Welt für Maschinen, Steuerung und Computer überhaupt erst begreifbar. Da die Anzahl von Sensorprinzipien und Wandlerbauformen schier unendlich ist, hier nur ein erster, sehr grober Überblick.

tact wiper over a resistive element or a coil of wire. By mechanically connecting the wiper to an object, any displacement registers as a proportional change in voltage or resistance.

A more sophisticated transducer for measuring angles or distances is an encoder. In contrast to a potentiometer, an encoder produces a digital output when a patterned mask is moved over a secondary transducer. The most common form is a rotary encoder, which consists of a code disk, a transparent film with radial opaque lines placed in the path of a light barrier. As the encoder shaft rotates, the light beam is interrupted by the lines on the code disk. This produces a pulse signal which can be sent to a counter or controller.

The most complex transducers for spatial measurements work by measuring the run time of a signal that has been sent from a transmitter and reflected off an object. This signal can be sound, light or radio waves. Ultrasonic transducers combine an ultrasound speaker and a microphone into an inexpensive device capable of measuring short to medium distances with reasonable accuracy. Light

or radio detection and ranging devices, or LiDAR and RADAR for short, excel at medium to large distances. LiDAR emits short infrared laser pulses and is often combined with rotating mirrors to create two- or three-dimensional distance maps with high accuracy and resolution. The short wave lengths of radio signals make it possible to penetrate fog and clouds and detect objects hundreds of kilometres away. Radar systems based on the Doppler Effect are also often used to measure the speed of airplanes and unsuspecting car drivers. <<< Matthias Meier >>>



acceleration // ək,sələ'reɪʃn	Beschleunigung
according to	gemäß, entsprechend
accuracy // 'ækjərəsi	Genauigkeit
ambient	Umgebungs-, umgebend
amplifier	Verstärker
angle	Winkel
attach, to // ə'tætʃ	befestigen, verbinden
bead // bi:d	Perle, Tropfen
beam	Strahl
bond	kleben, verbinden
capacitance // kə'pæsɪtəns	Kapazität
charge // tʃɑ:dʒ	Ladung
circuit // 'sɜ:kɪt	Stromkreis
coat, to	beschichten
coil	Spule
common	üblich, geläufig
conductance	Leitwert, Leitfähigkeit
conductor	Leiter
core	Kern
decrease, to // dɪ'kri:s	vermindern, verringern
device // dɪ'vaɪs	Gerät, Apparat
diaphragm // 'daɪəfrəm	Membran
displacement	Verschiebung, Verlagerung
distinction	Unterscheidung, Abgrenzung
divider	Teiler
encoder	Encoder, Geber
excel, to //	sich hervortun, sich auszeichnen
exception	Ausnahme
excitation // ,egzɪ'teɪʃn	Anregung
gap	Spalt, Zwischenraum
increase, to // ɪn'kri:s	erhöhen, steigern
inexpensive	kostengünstig, billig
infinite // 'ɪnfɪnət	unendlich
insulate, to	isolieren

interchangeably	austauschbar, abwechselnd
light barrier	Lichtschranke
opaque // əp'əɪk	undurchsichtig
pattern	Muster
patterned	gemustert
penetrate, to	durchdringen
property	Eigenschaft
quicksilver	Quecksilber
ranging	Entfernungsmessung
refer to, to // rɪ'fɜ:	nennen
regard, to	betrachten, erachten
related	ähnlich, verwandt
resistance	Widerstand
resistance temperature detector	Widerstandstemperturfühler
resistive	Widerstands-
resistor	Widerstand
resolution	Auflösung
semiconductor	Halbleiter
slide, to	schieben, gleiten
spatial // 'speɪʃl	räumlich
specimen // 'spesɪmən	Probe, Prüfkörper
strain	Dehnung, Deformation, Belastung
strain gauge // streɪn geɪdʒ	Dehnungsmessstreifen
stress	Spannung, Belastung
term // tɜ:m	Begriff, Bezeichnung
thermocouple	Thermoelement
torque // tɔ:k	Drehmoment
transducer	Wandler, Umformer
ultrasonic	Ultraschall-
ultrasound	ultraschall
unsuspecting	ahnungslos, arglos
vice versa // ,vaɪs 'vɜ:sə	umgekehrt
voltage	Spannung
wiper	Schleifer, Wischer

ARTS & CULTURE

Zeit ist ein abstraktes Konzept. Während die meisten Kulturen den Raum als Metapher nutzen, wenn sie über Zeit sprechen, variiert die Auffassung darüber wohin und wie die Zeit sich „bewegt“ doch stark. Eine linguistische Reise durch Raum und Zeit.

TALKING IN SPACE AND TIME

Time is an abstract concept. While most cultures use space as a metaphor when talking about time their notion of where and how time is ‘moving’ may vary. A linguistic journey through space and time.



Expressions linking space to time are a *common* part of our day-to-day lives. You might say the morning “flew by”, or that school exams are “fast *approaching*”. Right now, you might say summer is “just around the corner”, while anyone with the vaguest *awareness* of Game of Thrones will have heard the phrase “winter is coming”.

Unlike the physical space we *inhabit*, time cannot be seen or touched, *though* it structures every moment of our *waking* lives.

How, then, did humans come to talk so *effortlessly* about such a nebulous, abstract concept? The key lies in the way we project our understanding of space – the *tangible* dimensions we can interact with – to *conceptualise* time.

Explorations of how humans conceptualise time as space are *tied* closely to the study of language and *cognition*. Conceptual Metaphor Theory, developed by George Lakoff and Mark Johnson, *proposes* that our *conception* of the world is *governed* by metaphors, many of them *anchored* in the three dimensions of physical space.

Metaphors play an essential role in human *reasoning*, influencing how we talk about and *comprehend* abstract ideas. We use our awareness of space and movement as a *domain* in which we can better understand more complex concepts such as time.

Therefore, when we say a meeting is being “moved forwards”, we visualise time as an element that moves, and in which we move, reflecting our tendency to interpret abstract ideas through physical *experience*.

The idea of linguistic relativity, originally put forward by Benjamin Whorf and Edward Sapir, *suggests* that the language we speak *determines* how we interpret the world around us.

Studies have shown that different cultures and languages do not all *perceive* time in the same way. In English,

for example, we talk about future events as being in front of us – one might say we “have a bright future ahead” – while the past is, as per the popular expression, behind us.

However, the Aymara, an *indigenous* people of South America, see things the other way round. They place the past ahead, as it is already seen and therefore known, while the future is behind, because it cannot be seen, and is yet to be known.

In other languages, such as Mandarin Chinese, time is visualised as a vertical axis: events in the past are “above” while events in the past are “beneath”. “Last month” (上个月 –) therefore translates literally as “the month above”.

In many Western cultures, where text runs from left to right, there is a natural tendency to *associate* leftward movement with the past, and rightward movement with the future. This is not only reflected on paper – when drawing historical timelines, for example – but also in the *gestures* we make when speaking about past or future events: speakers of languages read from left to right tend to *gesture* to the left when talking about the past, and to the right when talking about the future.

However, this is far from universal. In cultures that write from right to left, such as in Arabic or Hebrew, such gestures are often *inverted*: while a Spanish or English speaker would gesture to the left to talk about the past, an Arabic or Hebrew speaker would point to the right.

NAVIGATING THROUGH TIME AND SPACE

Metaphors of time can be divided into “ego moving” and “time moving”, and this *distinction* illustrates the different ways of perceiving the *relationship* between space and time. In “ego moving” metaphors, a person moves towards a fixed point in time, for example, “we’re getting close to summer”.

In “time moving” metaphors, time *instead* moves towards the individual – “Summer is nearly here”.

A number of factors influence whether we use one type of metaphor or another. These include language structure, cultural perspectives towards an action or *destination*, and even a person’s emotional state. For example, in positive situations, or when speakers feel in control, they may *prefer* “ego moving” metaphors (“We are approaching the holidays”). When someone feels they have less control, or if the future seems to *impose* itself on the present, “time moving” metaphors (“Exams are coming up”) may *predominate* instead.

When analysing the *spatial* understanding of time, one particularly interesting linguistic phenomenon stands out: verbs of movement to describe the passage of time. Verbs like “*progress*”, “*approach*” or even “*pass*” are common examples.

The use of *particular* verbs to describe the passage of time may reflect our subjective perception of it. For example, when we say “time flies”, we know it *refers* to a *pleasant* situation. Happy moments often feel *fleeting*, so the verb “fly” represents an experience of joy or fun.

In contrast, when we are *bored* or waiting for something, we might say time “*drags*” to express *tedium* and slowness. In a lesson, for example, a student may feel that time “flies” or “drags”, depending on how interested they are in the subject, or how well it is being *taught*.

This demonstrates how our emotions influence both our perception of time, and the way language can express our own subjective experiences of it.

Our choice of verbs not only communicates an objective fact, but also our emotional and psychological state: whether an event is “long” or “short” depends on how we feel about it. This demonstrates the *interconnected* nature of cognition, emotion and language in our perception of the passage of time.

These metaphors, and their uses, offer a fascinating window into human cognition. They *reveal* how language and thought relate to each other to make sense of *temporal* experience. Recognising and analysing these differences allows us to *appreciate* the richness and diversity of human thought. It also *provides* us with tools to explore how different cultures and languages approach one of humanity’s most abstract, *yet* universal, concepts.

<<< Rosa Illán Castillo >>>

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<https://theconversation.com/why-do-metaphors-of-space-help-us-understand-time-229359>

<https://portalinvestigacion.um.es/investigadores/330966/detalle>
Homepage der Autorin Maria del Rosario Illán Castillo an der Universidad de Murcia.

<i>anchor, to</i> // 'æŋkə	verankern, fest machen
<i>appreciate, to</i> // ə'pri:ʃiət	wertschätzen, würdigen
<i>approach, to</i> // ə'prəʊtʃ	sich nähern, herankommen
<i>associate, to</i> // ə'səʊsiət	in Verbindung bringen, zuordnen
<i>awareness</i>	Bewusstsein, Kenntnis
<i>bored</i>	gelangweilt
<i>cognition</i> // kɒg'nɪʃn	Wahrnehmung, Erkenntnis
<i>common</i>	gängig, üblich, geläufig
<i>comprehend, to</i>	begreifen, verstehen
<i>conception</i>	Vorstellung, Idee
<i>conceptualise, to</i> // kən'septʃuəlaɪz	begrifflich erfassen
<i>destination</i>	Ziel
<i>determine, to</i> // dɪ'tɜ:mɪn	bestimmen, festlegen
<i>distinction</i>	Unterscheidung, Abgrenzung
<i>domain</i>	Bereich, Gebiet
<i>drag, to</i>	ziehen, schleppen
<i>effortlessly</i>	müheless, leicht
<i>experience</i> // ɪk'spɪəriəns	Erfahrung, Erleben
<i>exploration</i>	Erkundung, Erforschung
<i>expression</i>	Ausdruck, Wendung
<i>fleeting</i>	flüchtig, vergänglich
<i>gesture</i> // 'dʒestʃə	Geste, Gebärde
<i>gesture, to</i> // 'dʒestʃə	gestikulieren
<i>govern, to</i>	bestimmen, regieren
<i>however</i>	jedoch, allerdings
<i>impose on, to</i>	aufdrängen, überstülpen
<i>indigenous</i> // ɪn'dɪdʒənəs	einheimisch, eingeboren
<i>inhabit, to</i>	bewohnen
<i>instead</i>	stattdessen, anstelle
<i>interconnect, to</i>	vernetzen, miteinander verbinden
<i>invert, to</i>	umdrehen, umkehren
<i>link, to</i>	verbinden, verknüpfen
<i>notion</i> // 'nəʊʃn	Vorstellung, Auffassung
<i>particular</i>	besondere/r/s, speziell
<i>perceive, to</i> // pə'si:v	wahrnehmen, auffassen
<i>pleasant</i>	angenehm, erfreulich
<i>predominate</i> // prɪ'dɒmɪneɪt	überwiegen, vorherrschen
<i>prefer, to</i>	bevorzugen, vorziehen
<i>progress, to</i> // 'prəʊgres	vorankommen, Fortschritte machen
<i>propose, to</i>	vorschlagen, anregen
<i>provide, to</i>	bieten, liefern
<i>reasoning</i>	Denkfähigkeit, logisches Denken
<i>refer, to</i>	sich beziehen, verweisen
<i>relationship</i>	Beziehung, Verhältnis
<i>reveal, to</i>	zeigen, verraten, offenbaren
<i>spatial</i> // 'speɪʃl	räumlich
<i>suggest, to</i> // sə'dʒest	vorschlagen, behaupten
<i>tangible</i> // 'tændʒəbl	greifbar, fassbar
<i>teach, to (taught, taught)</i>	lehren, unterrichten
<i>tedium</i> // 'ti:diəm	Langeweile, Eintönigkeit
<i>temporal</i>	zeitlich
<i>though</i> // ðəʊ	obwohl, jedoch, obgleich
<i>tie, to</i>	binden, knüpfen
<i>wake, to</i>	wachen, aufwecken
<i>yet</i>	doch, zugleich

BUSINESS

Influencer zu werden scheint eine verlockende Alternative zu einem drögen Bürojob zu sein: Geld verdienen, indem man einfach nur in die Kamera lächelt und Produkte vorstellt, während man das tut, was man ohnehin gerne tut. In Wahrheit jedoch bedeutet Influencing harte Arbeit und erfordert mehr unternehmerisches Denken und Durchhaltevermögen als so manch anderer Job.

INFLUENCERS AT WORK

Becoming an influencer may seem like a lucrative alternative to a dreary office job: Earning money just by smiling into a camera and promoting products while doing what you love to do. In truth, influencing requires hard work and more entrepreneurial thinking and persistence than most other jobs.



< PHOTO: A. LOS MUERTOS CREW/PEXELS.COM >

You're hard at work, lying in a *hammock*, composing the perfect selfie on the beach. The *turquoise* sea sets off the idyllic sunset, and just visible through the *fronds* of a palm tree is the logo of the hotel which is paying you to promote it to your millions of followers on Instagram.

Click. The perfect shot. And another typically perfect day in the life of an influencer. Or is it?

Certainly a career as an influencer can seem *appealing*. The work generally involves promoting products or services through sponsored social media posts or "*branded content*", and communicating with people who are interested in what you do.

The industry is worth over £16 billion, with organisations from large *brands* such as Coca Cola through to local tourist boards *seeking* to *benefit* from this "authentic" form of marketing.

And for a small handful of influencers, the world of celebrity *beckons*. But for the *vast* majority our research, which involved interviewing influencers and brand representatives, *suggests* that making a living in this industry is hard work and poorly paid – if at all.

Here are three things to remember if influencing feels like the career for you.

#KnowYourWorth

There are no set *rates* of pay for influencers. Contracts are likely to be short and job protection is limited, which means career *trajectories* and pay are *unpredictable*.

For those who do get paid, earnings can *range* from anywhere between £10 to £10,000 for one post. One *survey* indicates that *average* monthly earnings for "micro-influencers" with 1,000 to 10,000 followers are around £1,135 per month, while for "mega-influencers" with over 1 million followers the *figure* is £12,279.

Rates are calculated based on things like the cost of content production and the metrics generated from social media algorithms, which include the numbers of followers an influencer has, in the same way that TV *advertising* rates are based on the number of expected viewers.

Financial *acumen* is key to avoiding working for free. Some influencers create "rate cards" or "media kits" containing key information for *prospective corporate* partners.

As one influencer explained: "When I work with brands or when they approach me for collaborations, I send them my media kit. That's where it's all listed – what reach I have, how many people follow me, what my engagement rate is, and my prices. It's a form of defining myself on this platform."

#EntrepreneurMindset

Behind almost every fantastic image or video lies administrative and creative effort. The *apparent* glamour of influencing can take a lot of hard *graft*, with plenty of time and energy invested into creating social media content.

One influencer commented: "Remember that you are wearing multiple hats – concept creator, set designer, stylist, lighting director, makeup artist, marketing specialist, and photographer – when you're posting for any brand."

So influencers need to multi-task, creating images, videos, blogs, podcasts and even their own *merchandise*.

Affiliate programmes are also a popular *avenue* for influencers to earn money from brands, where they are paid when one of their followers uses a link they have publicised to *purchase* a product or service. Amazon, *for instance*, runs its own affiliate programmes and *encourages* influencers to "select the best of Amazon's products and services, easily recommend them to your followers and earn commissions on qualifying purchases".

Given this vast portfolio of *tasks*, influencing work can be *relentless*. Social media is open for business 24 hours a day, so constantly *maintaining* relationships with followers and *fuelling* those social media algorithms means influencing can feel like a job which never stops.

The need to constantly be switched on can *take its toll*, as can *rejection* from brands and criticism from followers. We are only just learning about the mental health *struggles* that lie behind perfectly *curated* Instagram feeds.

#PassionProject

So why do influencers *stick* at it? Our work suggests that most influencers did not start out with a desire to *influence* others, but to provide a creative outlet for their *passions*.

They might be a Bangladeshi food enthusiast who began sharing restaurant tips with their friends and soon became a local food critic. Or maybe a British travel blogger who enjoyed posting pictures from romantic *getaways* and now commissions work from *tourism boards*. Or they could be an Australian fitness fanatic who began sharing healthy recipes online and now sells *nutritional* e-books, *supplements* and online coaching services.

Most of the successful influencers we spoke to started their career with a *genuine* love for something they wanted to share with others.

<i>acumen</i> // 'ækjəmən	Scharfsinn, Geschick
<i>advertising</i>	Werbung, Reklame
<i>affiliate programme</i>	Partnerprogramm
<i>apparent</i>	scheinbar, sichtbar
<i>appeal, to</i>	reizen, gefallen
<i>avenue</i> // 'ævənju:	Zugang, Straße
<i>average, to</i>	durchschnittlich betragen
<i>avidly</i> // 'ævidli	eifrig, leidenschaftlich
<i>beckon, to</i> // 'bekən	locken
<i>benefit, to</i>	profitieren, Nutzen ziehen aus
<i>brand</i> // brænd	Marke
<i>branded</i> // 'brændɪd	Marken-
<i>commit, to</i>	verpflichten, binden
<i>content</i> // 'kɒntent	Inhalt
<i>corporate</i>	Unternehmens-, unternehmerisch
<i>curate, to</i>	kuratieren, sorgfältig auswählen
<i>dreary</i> // 'driəri	trist, trostlos, dröge
<i>encourage, to</i>	ermutigen, ermuntern
<i>endeavour</i> // ɪn'devə	Bemühung, Bestrebung
<i>entrepreneur</i> // ,ɒntɹəprə'nɜ:	Unternehmer/in
<i>entrepreneurial</i> // ,ɒntɹəprə'nɜ:riəl	unternehmerisch
<i>figure</i>	Betrag, Zahl
<i>for instance</i>	zum Beispiel
<i>frond</i>	Wedel
<i>fuel, to</i>	befeuern, anheizen, beschicken
<i>fulfilment</i>	Erfüllung, Verwirklichung
<i>genuine</i> // 'dʒenjuən	echt, ernsthaft
<i>getaway</i>	Ausflug, Kurzurlaub
<i>goal</i> // gəʊl	Ziel, Zweck
<i>graft</i>	hier: Schinderei, Schufterei

For them, influencing brought enjoyment and *fulfilment*. Most do not even see themselves as influencers, but as content creators *avidly committed* to their audience. One influencer laughed when we referred to him as an influencer, preferring to describe himself as “just a regular person who likes to cook”.

Many influencers also enjoyed their online *sense of community*, sharing tips with one another, or participating in “engagement circles”, where they would like and share other influencers’ content to increase its visibility. There was a strong sense of influencing being a collective *endeavour*, of working towards a shared *goal* of getting paid for doing work that they love.

Overall we found that being a successful influencer requires *resilience*, management *skills* and passion. Master all of this, and maybe one day you too could be taking that selfie in a beach hammock, with hopefully some extra cash to spend on an ice cold drink at the end of the working day.

<<< Sarah Glotzer, Hannah Trittin-Ulbricht >>>

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<https://researchportal.bath.ac.uk/en/persons/sarah-glozer>
www.leuphana.de/institute/imo/personen/hannah-trittin-ulbricht.html
Webseiten der Autorinnen Dr. Sarah Glotzer an der University of Bath und Prof. Dr. Hannah Trittin-Ulbricht an der Leuphana Universität Lüneburg.

<i>hammock</i> // 'hæmək	Hängematte
<i>influence, to</i>	beeinflussen, einwirken
<i>maintain, to</i>	aufrechterhalten, pflegen
<i>merchandise</i> // 'mɜ:tʃəndaɪs	Ware, Handelsartikel
<i>mindset</i>	Denkweise, Mentalität
<i>nutritional</i> // nju'triʃənəl	Ernährungs-
<i>passion</i>	Leidenschaft, Vorliebe
<i>persistence</i>	Ausdauer, Durchhaltevermögen
<i>promote, to</i>	bewerben, fördern
<i>prospective</i>	voraussichtlich, angehend
<i>purchase, to</i> // 'pɜ:tʃəs	kaufen, erwerben
<i>range, to</i> // reɪndʒ	reichen, sich bewegen
<i>rate</i>	Preis, Tarif, Quote, Satz
<i>rejection</i> // rɪ'dʒekʃən	Ablehnung, Zurückweisung
<i>relentless</i>	unerbittlich, unbarmherzig
<i>resilience</i> // rɪ'zɪliəns	Widerstandsfähigkeit
<i>seek, to</i>	anstreben, begehren, suchen
<i>sense of community</i>	Gemeinschaftsgefühl
<i>skill</i>	Fähigkeit, Können, Kompetenz
<i>stick, to (stuck, stuck)</i>	hängenbleiben, kleben
<i>struggle</i>	Kampf, Ringen
<i>suggest, to</i> // ə'dʒest	nahelegen, hindeuten
<i>supplement</i>	Zusatz, Ergänzung
<i>survey</i> // 'sɜ:veɪ	Umfrage, Untersuchung
<i>take a toll, to (took, taken)</i>	seinen Tribut fordern
<i>task</i>	Aufgabe, Tätigkeit
<i>tourism board</i>	Fremdenverkehrsamt
<i>trajectory</i> // trə'dʒektəri	Bahn, Kurve
<i>turquoise</i> // 'tɜ:kwɔɪz	türkis
<i>unpredictable</i>	unvorhersehbar
<i>vast</i> // vɑ:st	groß, riesig



SUPERCAR SUBMARINE

Supercars are so yesterday. You might as well try something new when you have a million to spare. How about a submersible? U-Boat Worx's Nemo is a sleek-looking, recreational two-person sub that is poised to become the supercar of the depths.

While for many of us the idea of a £1 million *purchase* is entirely absurd, we can't help but wonder what we could have for this *amount* of money... holidays, homes, or perhaps the fastest and most attractive supercars.

Despite their extortionate cost, we see these supercars all the time – on our televisions, in the movies and, of course, on our roads, and it is this visibility that fuels many a dream to own one.

Dutch company U-Boat Worx is now taking this philosophy to the water, as it builds on its plans to mass produce what it hopes could one day become the 'supercar' of the ocean: the privately owned submersible.

First *founded* in 2005, the company has become the largest builder of private *submarines* in the market, in terms of output, *commissioned vessels*, number of *employees* and units in active use. Indeed, the Netherlands-based company has produced more submarines than all active *manufacturers* combined currently.

The firm's product *range* is nothing short of extensive, from the C-Researcher series that can hold up to five passengers and dive to a 3000-meter maximum depth, to the UWEP

or Under Water Entertainment Platform that can take up to 120 passengers, crew and *staff* for a 150-meter dive.

The fully configurable UWEP is described by the company as 'a new class of exceptionally *spacious*, privately-operated entertainment submarines,' and, with enough space for a restaurant, casino or *wedding venue*, this product falls firmly at the more extreme end of its range.

However, U-Boat Worx's main *aim* is to make submarines less out-of-reach for everyday consumers, by making it possible to privately own a sub and *explore* the seas at your own *leisure*. The *frontrunner* of this vision is the Nemo, the world's first series-produced submersible, named after Captain Nemo – the designer and captain of the Nautilus submarine in Jules Verne's 1869 classic 'Twenty Thousand Leagues Under the Sea.'

THE TEN COMMANDMENTS

Independent design engineer Rob Wolkers, who has *previously developed* an E-Fun scooter and Avion's A320 flight simulator, was brought in by U-Boat Worx to bring this vision to life.



Supersportwagen sind sowas von gestern. Sie könnten doch mal was Neues probieren, wenn Sie eine Million übrig haben. Wie wär's mit einem Tauchboot? U-Boat Worx's Nemo ist ein schnittiges Freizeit-U-Boot für zwei Personen, das der Supersportwagen der Tiefe werden könnte.

SUBMERSIBLES

“Normally, with a project like this, you get a list of set requirements,” said Wolkers. “For the Nemo, we called it the ten commandments. They weren’t really measurable requirements, the brief was more focused on the feel and experience, and that’s what I liked about the opportunity.”

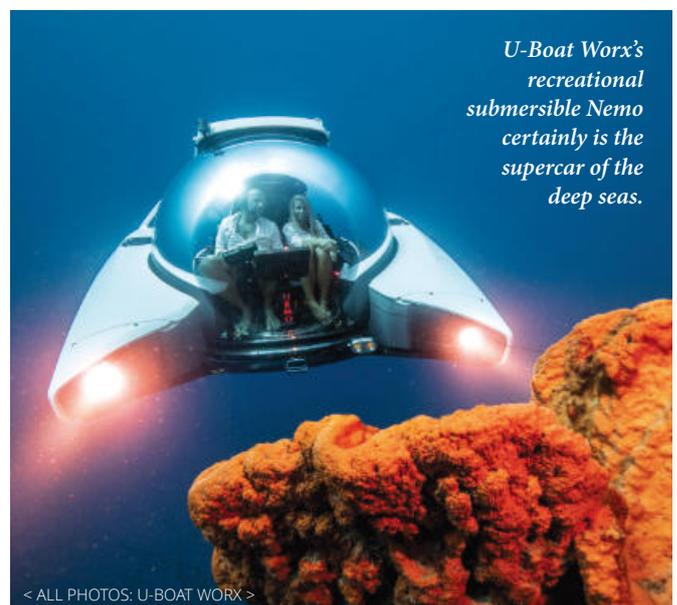
These ‘ten commandments’ included creating an ultimate driving experience, ensuring the sub was easy to operate and offered customers an unobstructed view of their surroundings whilst exploring; ensuring that it was maintenance friendly, in terms of access to the internal structure; and, above all else, that the Nemo was a consumer product rather than a machine.

“The main goal was to make a submersible for as wide an audience as possible, because that was always the dream of U-Boat Worx’s founder, Bert Houtman,” said Wolkers.

“He has always wanted to build a sub that was as accessible as possible for everyone – not only price wise, but also how you can move and deploy the submersible. You don’t need a super yacht to own a Nemo, you can put it on a trailer behind a car. The total cost of ownership is much cheaper compared to other submarines, but you still get the same awesome experience when you’re in the water.” >>>

access // 'æksəs	Zugang, Zugänglichkeit
accessible // ək'sesəbl	zugänglich
aim	Ziel, Absicht
amount	Betrag, Menge
audience	Zielgruppe, Publikum
brief	hier: Vorgabe, Instruktionen
commandment	Gebot
commission, to	bestellen, auch: in Dienst stellen
deploy, to	einsetzen, ausladen
despite	trotz, ungeachtet
develop, to	entwickeln, ausarbeiten
employee	Mitarbeiter/in, Angestellte(r)
ensure, to	sicherstellen, gewährleisten
experience // ik'spiəriəns	Erlebnis, Erfahrung
explore, to	erkunden, erforschen
extortionate // ik'stɔ:ʃənət	ungeheuer, maßlos
found, to	gründen
frontrunner	Vorreiter/in
fuel, to	schüren, anheizen
goal // gəʊl	Ziel, Absicht
in terms of // ɪn tɜ:mz əv	in Bezug auf
league // li:g	hier: Meile
leisure // 'leɪzə	Freizeit, Muße
maintenance // 'meɪntənəns	Wartung, Instandhaltung
manufacturer	Hersteller/in
measurable	messbar
opportunity	Gelegenheit
poised to, to be	bereit sein
previously	zuvor, bislang
purchase // 'pɜ:tʃəs	Kauf, Anschaffung
range // reɪndʒ	Angebot, Bereich, Sortiment
recreational // ,rekri'eɪʃənəl	Freizeit-, der Erholung dienend

requirement	Anforderung, Vorgabe
sleek	elegant, schnittig
spacious	geräumig, großzügig
spare // speə	übrig, überzählig
staff	Personal, Belegschaft
submarine	Unterseeboot
submersible // səb'mɜ:səbl	Tauchboot, Unterwasserfahrzeug
surrounding	Umgebung, Umfeld
unobstructed	ungehindert, uneingeschränkt
venue // 'venju:	Veranstaltungsort
vessel // 'vesl	Schiff, Wasserfahrzeug
wedding	Hochzeit



U-Boat Worx's recreational submersible Nemo certainly is the supercar of the deep seas.

< ALL PHOTOS: U-BOAT WORX >



It's all about making a splash: Thanks to its easy controls and great view, Nemo is the perfect vessel for a romantic dive for two.

With a single lifting point, U-Boat Worx said the sub is easily placed on a flat *surface* without the need for a *cradle* or *davit*, making it easily *deployable* on land or ship-board. Complementary beach *launchers*, *towable* car trailers, floating submarine houses and small *support crafts* have also been developed to allow simple submarine mobilisation.

It should be noted that technically, because it needs to be transported and *supported* by a mother ship or vehicle, the Nemo is defined as a submersible, *rather than* a submarine. Submarines, like the rest of U-Boat Worx's portfolio, instead have enough power to *launch* from and return to a port completely *independently*.

The Nemo, which can hold two passengers and dive to a maximum of 100 meters at a rate of three knots, is the lightest submersible built to date, weighing in at 2,500 kilograms with base specifications. The sub is just 2.31 meters wide, with a height of 1.55 meters and a length of 2.8 meters, which U-Boat Worx said takes up less space than two jet-skis *stored side-by-side*.

LIKE A SHIP WITHIN A BOTTLE

Wolkers said that the main *challenge* of working within these dimensions was: "Getting all the systems you need for the functionality, as well as all the safety systems, on board and within the *interior*."

"Then, of course, it's not only getting all the systems in there, but making sure they are accessible for repairs and maintenance. One of the big challenges was that every interior part had to fit through the submersible's *hatch* – it was like building a model ship within a bottle."

Despite this, the Nemo engineering team was able to develop an internal system within the maximum dimensions of the submersible, which works by controlling the air and water *intake* in its tanks.

The Nemo's ballast tanks aren't *pressurised*, and instead are open tanks that, when the sub is floating on the water's surface, are filled with air. To begin diving, the pilot has to open the *valves* of the tanks, which then *displaces* the air with water and, of course, forces the Nemo to sink *due to* the change in its *density*.

Once *submerged*, the sub can be manoeuvred by controlling the amount of compressed gas pushed back in or out of the tanks. To return to the surface, the tanks are fully filled with the compressed gas, to displace the water back into the ocean and make the sub *buoyant* once more.

It is also powered by four silent electrical *thrusters*, which U-Boat Worx said makes *hovering* close to a point of interest or *descending* to the seabed against strong *currents* 'simple and easy'.

"Whilst there's no such thing as an 'international submarine license,' U-Boat Worx has its own two-week training course, which isn't just practice but theory, too. You

have to know how the systems work and the principles of the sub as well,” said Wolkers.

You can, *however*, still *experience* driving the Nemo without a licence, as the Manta Controller allows for the trained pilot to easily transfer control to the passenger. U-Boat Worx said the intuitive Manta controls allow for *supervised* passenger *steering*, with ‘pinpoint precision manoeuvring’ and quick access to intelligent pilot assistance functions such as *auto-heading* and *auto-depth*.

The Nemo team has also developed the Marlin Controller, a *wireless remote* that can navigate the submersible whilst it is on the surface, and move it away from the support vessel when underwater, without a pilot inside.

Whilst these smart systems offer great control over the Nemo, Wolkers highlights the particular need for training if they were to *fail*, despite how unlikely the scenario is.

“The Nemo has a manual *override* to drop weight and total mass if the power fails, so that it can float back up to the surface. If everything else fails, it has four days’ worth of *life support*, including food and *oxygen*, as well as a manually deployed *buoy attached* to a line to notify those above of your whereabouts,” he said.

RECREATION AND RESEARCH

When *considering* the current use-cases for the *invention*, Wolkers said it is mainly recreational, but that the Nemo has been taken out on a few research missions – including a Greenpeace mission in 2023, to reach a never-before-studied reef ecosystem in Mexico.

Looking ahead, the Nemo team hopes to *increase* the sub’s mass production plan, so that the level of *accessibility* and the number of use-cases can continue to grow. >>>

<i>accessibility</i>	Zugänglichkeit, Erreichbarkeit
<i>attach, to</i> // ə'tætʃ	befestigen, montieren
<i>buoy</i> // bɔɪ	Boje
<i>buoyant</i> // 'bɔɪənt	schwimmend, schwimmfähig
<i>challenge</i> // 'tʃælɪndʒ	Herausforderung
<i>consider, to</i>	betrachten, erachten
<i>cradle</i>	Wiege, hier: Krangeschirr
<i>craft</i>	Schiff, Boot
<i>current</i> // 'kʌrənt	Strömung, Strom
<i>davit</i>	Davit, Boots Kran
<i>density</i>	Dichte
<i>deployable</i>	einsetzbar
<i>descend, to</i> // dɪ'send	absteigen, sinken
<i>displace, to</i>	verdrängen, ersetzen
<i>due to</i> // 'dju: tə	aufgrund, wegen
<i>experience, to</i> // ɪk'spɪəriəns	erfahren, erleben
<i>fail, to</i>	ausfallen, versagen
<i>hatch</i> // hæʃ	Luke, Klappe
<i>heading</i>	Kurs
<i>hover, to</i>	schweben
<i>however</i>	jedoch, allerdings
<i>increase, to</i>	erhöhen, steigern
<i>independently</i>	unabhängig

<i>intake</i>	Einlass, Aufnahme
<i>interior</i>	Innenraum
<i>invention</i>	Erfindung
<i>launch, to</i> // lɔ:ntʃ	vom Stapel lassen, starten
<i>launcher</i> // 'lɔ:ntʃə	Startvorrichtung
<i>life support</i>	Lebenserhaltungssystem
<i>override</i>	Eingriff, Überbrückung
<i>oxygen</i> // 'ɒksɪdʒən	Sauerstoff
<i>pressurise, to</i>	mit Druck beaufschlagen
<i>rather than</i>	statt, eher als
<i>recreation</i> // ,ri:kri'eɪʃn	Erholung, Freizeit
<i>remote</i>	Fernsteuerung
<i>steering</i>	Steuerung, Lenkung
<i>store, to</i>	lagern, aufbewahren
<i>submerge, to</i> // səb'mɜ:dʒ	untertauchen
<i>supervise, to</i>	überwachen, beaufsichtigen
<i>support</i>	Hilfs-, Unterstützungs-
<i>support, to</i>	unterstützen
<i>surface</i> // 'sɜ:fɪs	Oberfläche
<i>thruster</i>	Strahlruder, Schubdüse
<i>towable</i> // 'təʊəbl	anhängbar, abschleppbar
<i>valve</i> // vælv	Ventil
<i>wireless</i>	drahtlos

There are very few things you actually want to tow behind a Bentley – a £1 million recreational submersible is certainly one of them.



Due to the Nemo's more accessible price compared to other submarines, the market is bigger, and U-Boat Worx hopes that, with this larger market, it will be able to produce more for *instant* purchases.

"If the production numbers get bigger, there's definitely more optimisation needed, for individual parts and making the production more efficient," said Wolkers.

"As engineers, we are always thinking of ways to make something better. There has to come a point where you finish with the designing and move onto the building. In general, I get a lot of *credit* for this design, but it's a big team effort from the *initial* concept to the final product."

Certainly, with every sale – *estimated* by Wolkers to be up to around 20 now – U-Boat Worx gets one step closer to making its dream of creating a volume production 'super-car' submarine a reality.

Perhaps, in ten years' time, it won't be the fastest, most attractive cars that we all dream of owning, but our own submersible instead.

<<< Ellie McCann >>>



Dieser Artikel ist ursprünglich in 'The Engineer', Ausgabe May 2024, erschienen. Er wird hier mit freundlicher Genehmigung der Mark Allen Group veröffentlicht. Der Originalbeitrag findet sich unter www.theengineer.co.uk/content/in-depth/designing-nemo-building-a-volume-production-submersible

<https://Nemo-submarine.com>

Webseite des Nemo von U-Boat Worx mit allen Informationen zu dem kleinen Unterseeboot.

<i>credit</i>	<i>hier: Ansehen, Auszeichnung</i>
<i>estimate, to</i>	<i>schätzen, annehmen</i>
<i>initial // iˈniʃl</i>	<i>anfänglich</i>
<i>instant</i>	<i>sofortig, unmittelbar</i>

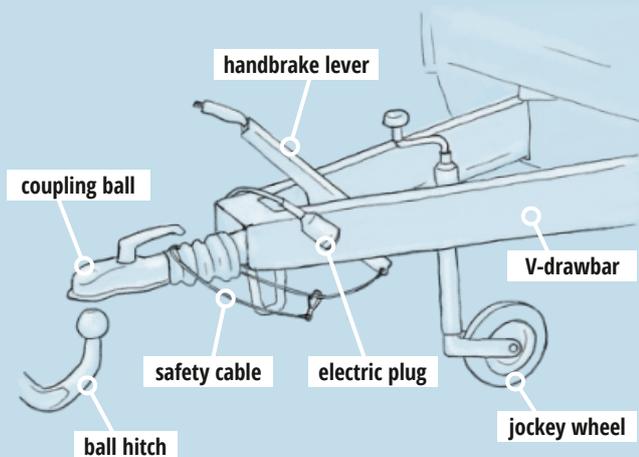
Links, Vokabeln & mehr unter

www.inchbyinch.de/inch41/nemosub



TECH EXTRAS

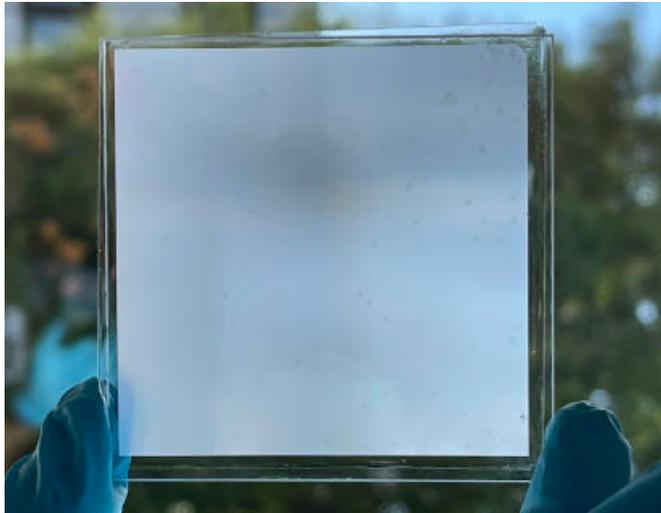
PICTORIAL TOW BAR



MINI DICTIONARY SHIPBUILDING

<i>azimuth propeller</i>	<i>Ruderpropeller</i>
<i>ballast tank</i>	<i>Ballasttank</i>
<i>buoyancy</i>	<i>Auftrieb</i>
<i>capsize, to</i>	<i>kentern</i>
<i>controllable pitch propeller</i>	<i>Verstellpropeller</i>
<i>displacement</i>	<i>Verdrängung (auf Spanten)</i>
<i>engine</i>	<i>Maschinenanlage</i>
<i>fixed pitch propeller</i>	<i>Festpropeller</i>
<i>hatch</i>	<i>Luke</i>
<i>hub cap</i>	<i>Propellernabenbirne</i>
<i>inline thruster</i>	<i>Ring-Propeller</i>
<i>lift</i>	<i>Auftrieb</i>
<i>manhole</i>	<i>Mannloch</i>
<i>moor, to</i>	<i>festmachen</i>
<i>permanent ballast</i>	<i>Festballast</i>
<i>pontoon</i>	<i>Ponton</i>
<i>power train</i>	<i>Antriebsstrang</i>
<i>pump-jet</i>	<i>Wasserstrahlantrieb</i>
<i>rudder</i>	<i>Ruder</i>
<i>sea trial</i>	<i>Probefahrt</i>
<i>stabilizing fin</i>	<i>Stabilisierungsflosse</i>
<i>thrust</i>	<i>Schub</i>
<i>wake adapted propeller</i>	<i>Nachstrompropeller</i>
<i>wash bulkhead</i>	<i>Schlagschott</i>
<i>watertight</i>	<i>wasserdicht</i>

Forschende des Karlsruher Instituts für Technologie (KIT) haben ein neues, polymerbasiertes Material entwickelt, das gleichzeitig Sonnenlicht ins Innere lässt, für ein angenehmeres Raumklima sorgt und sich selbst reinigt. Die Neuentwicklung könnte in Zukunft Glaskomponenten in Wänden und Dächern ersetzen.



< PHOTO: GAN HUANG, KIT >

for work and living. In greenhouses, the high light transmittance could *increase yields* because the photosynthesis efficiency is *estimated* to be nine percent higher than in greenhouses with glass roofs,” says Gan Huang, a Group Leader at IMT. The micro-pyramids also give the PMMM film superhydrophobic properties, similar to a lotus leaf: water *beads* up in *droplets* and removes dirt and dust from the *surface*. This self-cleaning function makes the material easy to maintain and *durable*. <<< >>>

www.nature.com/articles/s41467-024-48150-2

Der wissenschaftliche Artikel zum neuen, lichtdurchlässigen, multifunktionalen Metamaterial.

www.lti.kit.edu/index.php

Webseite des Lichttechnischen Instituts am KIT, wo das neue Metamaterial entwickelt wurde.

Maximizing natural light in buildings is popular and can save on energy costs. However, traditional glass roofs and walls also present problems such as glare, lack of privacy, and overheating. Alternative solutions, such as coatings and light-diffusing materials, have not yet provided a comprehensive remedy.

Researchers at the Institute for Microstructure Technology and the Light Technology Institute at KIT have now developed a novel polymer-based metamaterial that combines various properties and could replace glass components in construction in the future. The Polymer-based Micro-Photonic Multi-Functional Metamaterial (PMMM) consists of microscopic pyramids made of silicone. These micro-pyramids measure about ten micrometres, which is about one-tenth the diameter of a hair. The PMMM film serves several functions: light diffusion, self-cleaning, and radiative cooling while maintaining a high level of transparency. “A key feature is the ability to efficiently radiate heat through the Earth’s atmosphere’s long-wave infrared transmission window, releasing heat into the cold expanse of the universe. This allows for passive radiative cooling without electricity consumption,” explains Bryce S. Richards, Professor at IMT and LTI.

In the lab and in outdoor experiments under open skies the material achieved cooling of 6°C compared to the ambient temperature. Additionally, it showed a high spectral transmittance, or transparency, of 95 percent. In comparison, glass typically has a transparency of 91 percent. At the same time, the micro-pyramid structure scatters 73 percent of the incoming sunlight, resulting in a blurry appearance. “When the material is used in roofs and walls, it allows for bright yet glare-free and privacy-protected indoor spaces

ability	Fähigkeit, Vermögen
ambient // 'æmbiənt	Umgebungs-, umgebend
appearance	Aussehen, Erscheinung
bead, to	perlen
blurry	unscharf, verschwommen
coating	Beschichtung, Belag
comparison	Vergleich
comprehensive	vollständig, umfassend
consist of, to	bestehen aus
consumption	Verbrauch
develop, to	entwickeln
diameter // daɪ'æmɪtə	Durchmesser
droplet	Tröpfchen
durable // 'djʊərəbl	haltbar, langlebig
estimate, to	schätzen, annehmen
expanse // ɪk'spæns	Weite, Ausdehnung
glare // gleə	Blendung, blendendes Licht
however	allerdings, jedoch
increase, to	erhöhen, steigern
lack	Mangel, Fehlen
leaf	Blatt
light-diffusing	lichtstreuend
maintain, to	bewahren, erhalten
not yet	noch nicht
property	Eigenschaft
provide, to	bieten, liefern
radiate, to	abstrahlen, abgeben
remedy	Abhilfe, Gegenmittel
scatter, to	streuen, zerstreuen
solution // sə'lʊ:ʃn	Lösung
surface // 'sɜ:fɪs	Oberfläche
transmittance	Durchlässigkeitsgrad, Lichtdurchlässigkeit
yield // ji:ld	Ertrag

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 Erfolg hat nicht lange gehalten.

The success did not *keep* long.

The success did not *hold* long.

The success did not *last* long.

Don't forget to use the *blinker* when you overtake.

Don't forget to use the *indicator* when you overtake.

Don't forget to use the *signaller* when you overtake.

Nicht vergessen, beim Überholen den Blinker einzusetzen.

Ich wurde auf der Autobahn A3 geblitzt. 60,00 € Strafe!

I was *flashed* on the A3 motorway. € 60.00 fine!

I was *radared* on the A3 motorway. € 60.00 fine!

I was *blitzed* on the A3 motorway. € 60.00 fine!

Can you please bring us up to date on the latest *stage* of affairs?

Can you please bring us up to date on the latest *stand* of affairs?

Can you please bring us up to date on the latest *state* of affairs?

Kannst du bitte über den neuesten Stand der Dinge berichten?

Die letzte Lieferung war vor zwei Tagen.

The last delivery was *two days before*.

The last delivery was *two days ago*.

The last delivery was *for two days*.

We can *skip over* the next three slides.

We can *spring over* the next three slides.

We can *jump over* the next three slides.

Die nächsten drei Folien können wir überspringen.

//// Answers ////

<p>The success did not <i>last</i> long. <i>to keep</i> = behalten >>> You have had my hedge clippers for so long, just <i>keep</i> them. I'll buy new ones. <i>to hold</i> = (fest)halten >>> Can you <i>hold</i> my bag for a moment while I pay for the car park?</p> <p>I was <i>flashed</i> on the A3 motorway. €60.00 fine! <i>radared</i> = nicht üblich <i>blitzed</i> = ugs. sehr betrunken >>> He was totally <i>blitzed</i> on Saturday; doesn't remember anything.</p> <p>The last delivery was <i>two days ago</i>. <i>two days before</i> = zuvor, bevor (ich etwas anderes gemacht habe) >>> We were quicker. Our main rival submitted their bid on the deadline, but we had already done it <i>two days before</i>. <i>for two days</i> = zwei Tage lang >>> We stayed in Rome <i>for two days</i> and then moved south to Sicily.</p>	<p>Don't forget to use the <i>indicator</i> when you overtake. <i>blinker</i> = Scheuklappe >>> In a horse race some horses need to wear <i>blinkers</i> to focus their attention. <i>signaller</i> = Stellwerker, Signalgeber >>> My grandfather worked for 40 years as a <i>signaller</i> on the railways.</p> <p>Can you please bring us up to date on the latest <i>state</i> of affairs? <i>stage</i> = u.a. Phase >>> Everything is running to plan; we can now move on to the final <i>stage</i> of the project. <i>stand</i> = u.a. Messestand >>> We have designed a completely new <i>stand</i> for this year's fair.</p> <p>We can <i>skip over</i> the next 3 slides. <i>to spring over</i> = zum nächsten Thema übergehen (nicht so üblich) >>> Let's now <i>spring over</i> to the topic of testing. <i>to jump over</i> = überspringen (körperlich) >>> The gate was locked so we had to <i>jump over</i> it to get in.</p>
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WHERE IN THE WORLD IS MAGLEV?

Magnetic levitation technology has been under development for decades. After a few failed experiments all around the world, today, the technology seems to be thriving only in East Asia. What makes the maglev so attractive for this region?

Maglev brings to mind the future. Arguably, it has been doing so for more than a century – the concept dates back to the early 1900s, when German engineer Alfred Zehden was awarded a patent for a system that would propel a train using magnetism.

In basic terms, maglev is a form of high-speed transportation in which a train is held above its tracks with magnetic levitation (from which the word maglev is derived). There is variation between designs: they can be monorail or dual rail; use conventional or supercooled, superconducting electromagnets; or even be slotted inside gigantic vacuum tubes to minimise drag. What these models all have in common, and what distinguishes them from conventional high-speed rail, is levitation and lack of an engine: strong magnetic fields hold the train several centimetres above the track, keep it horizontally stable and propel it forward.

Removing friction between rails and wheels (rolling resistance) allows these trains to push towards speeds comparable with those of passenger aircraft without any direct

greenhouse gas emissions. The current train speed record, 603km/h, was set by the Japanese L0 Series Maglev in 2015.

Maglev trains have advantages beyond speed, however: they cannot be defeated by ice or leaves on their tracks; less maintenance is required (no wheels to wear down tracks and fewer moving parts to malfunction overall); they are less noisy than conventional rail; and they offer better acceleration and deceleration thanks to there being no need to carry onboard propulsion equipment.

After the Second World War, serious efforts began to build these trains of the future, with projects spanning continents.

For decades, British engineers played a leading role. In the 1940s, the first full-sized working model of the linear induction motor – which, ideally for maglev, does not require contact between wheel and track – was created by Professor Eric Laithwaite, an electrical engineer at Imperial College London. In the 1970s, he found an arrangement of magnets (the ‘magnetic river’) that could provide the lift, stability and thrust required for a maglev train. This system



An der Magnetschwebetechnik wird seit Jahrzehnten gearbeitet. Nach ein paar gescheiterten Experimenten in der ganzen Welt scheint die Technologie heute nur noch in Ostasien erfolgreich eingesetzt zu werden. Was macht die Magnetschwebebahn so attraktiv für diese Region?

PHOTO: MARYLAND GOV.PICS/PATRICK/REUTERS.COM/ANDRASFAPICS/WIKIMEDIA COMMONS >

was *immortalised* in the 1977 James Bond film ‘The Spy Who Loved Me’, propelling a tea *tray* with a *razor*-sharp edge into the neck of a dummy – one of Q’s sillier *gadgets* in a crowded field. For his critical *contributions*, Laithwaite became known as the ‘father of maglev’.

COMMERCIALISING MAGLEV

The first commercial maglev service opened in 1984. Simply called Maglev, it *shuttled* passengers between Birmingham airport and Birmingham International station in a boxy vehicle on a 600-meter-long track at 36 km/h. *Despite* much fanfare, it was *unreliable* and expensive to *maintain* – as a one-of-a-kind system, replacement parts were hard to *source*. It was closed in 1995.

Germany’s commercial maglev service, the M-Bahn, also failed to *endure*. It carried passengers along a 1.6-kilometer-long track in Berlin at 80 km/h from 1989 to 1991, when *reunification* rendered it *redundant*. However, a German technology partnership between Siemens, ThyssenKrupp and Adtranz outlived the M-Bahn and developed the Transrapid maglev system. This system was the real deal – even breaking 483 km/h with passengers onboard – and seemed to be lined up to provide the first intercity maglev connections, beginning with Hamburg-Hannover. In 2006, however, >>>

At 603 kph, the Japanese L0 Series is the fastest train in the world. The maglev train will run on the Chūō Shinkansen line between Tokyo and Nagoya, with plans for extension to Osaka

<i>acceleration</i> // ək,selə'reɪʃn	Beschleunigung
<i>advantage</i>	Vorteil, Nutzen
<i>arguably</i>	wohl, bestreitbar
<i>award a patent, to</i>	ein Patent erteilen
<i>comparable</i>	vergleichbar
<i>contribution</i>	Beitrag, Beteiligung
<i>current</i> // 'kʌrənt	aktuell, momentan
<i>deceleration</i> // ,di:selə'reɪʃn	Verlangsamung, Verzögerung
<i>defeat, to</i>	besiegen, bezwingen
<i>derive, to</i>	ableiten
<i>despite</i>	trotz, ungeachtet
<i>development</i>	Entwicklung
<i>distinguish, to</i> // dɪ'stɪŋɡwɪʃ	unterscheiden, kennzeichnen
<i>drag</i>	Luftwiderstand
<i>effort</i> // 'efət	Anstrengung, Bemühung
<i>endure, to</i>	Bestand haben, überdauern
<i>fail, to</i>	scheitern, versagen
<i>friction</i>	Reibung
<i>gadget</i> // 'gædʒɪt	technische Spielerei, Apparat
<i>however</i>	jedoch, allerdings
<i>immortalise, to</i>	verewigen
<i>in basic terms</i> // tɜ:mz	einfach ausgedrückt
<i>in common</i>	gemeinsam
<i>lack</i>	Fehlen, Mangel
<i>leaf (pl. leaves)</i>	Blatt, Laub
<i>levitation</i>	Schweben
<i>lift</i>	Auftrieb
<i>maglev</i> // 'mæglev	Magnetschwebebahn
<i>maintain, to</i>	warten, instandhalten
<i>maintenance</i> // 'meɪntənəns	Wartung, Instandhaltung
<i>malfunction, to</i>	nicht funktionieren, ausfallen
<i>propel, to</i> // prə'pel	antreiben, vorwärtstreiben
<i>provide, to</i>	bieten, liefern
<i>rail</i>	Schiene, Gleis
<i>razor</i> // 'reɪzə	Rasiermesser
<i>redundant</i>	überflüssig
<i>render, to</i>	machen
<i>require, to</i>	erfordern, benötigen
<i>reunification</i>	Wiedervereinigung
<i>rolling resistance</i>	Rollwiderstand
<i>shuttle, to</i>	pendeln
<i>slot, to</i>	einschieben
<i>source</i>	Quelle, Ursprung
<i>superconducting</i>	supraleitend
<i>thrive, to</i> // θraɪv	gedeihen, florieren
<i>thrust</i>	Schub
<i>track</i>	Gleis, Spur, Schienenstrang
<i>tray</i>	Tablett, Schale
<i>unreliable</i>	unzuverlässig
<i>wear down, to</i> // weə daʊn	abnutzen, abfahren



The M-Bahn in Berlin (top left) was the only German maglev to carry passengers. Its successor, the Transrapid (top right) was an ill-fated project which ended in tragedy. Still, the Shanghai Transrapid based on the design is currently the maglev with the longest track.

23 people were killed when a Transrapid train crashed into a maintenance vehicle left parked on the test track. This *fatal accident* – combined with costs over-running on a Transrapid Munich airport shuttle which was eventually *binned*, political *challenges* presented by local opposition, land *acquisition* complications and *objections* from *environmental* groups – *spelled the end* for maglev in Germany.

But Transrapid had already been *commissioned* to build a maglev shuttle for Shanghai airport. By the 2010s, East Asia was the only home for maglev.

Japanese engineers had been developing their own maglev technologies since the 1960s. Much of the country's rail infrastructure had been destroyed in the war, so new high-speed infrastructure was built to replace it. The *expertise* in conventional high-speed rail that was *established* by that *effort* helped *nurture* expertise in maglev. Professor Iain Docherty, *dean* of the Institute for Advanced Studies at the University of Stirling, says: "The technologies are essentially not that different. It's high-power electrical engineering and *power supply* systems: a lot of the *core* technologies are pretty similar between them because it's all about moving very significant electricity supply around and making sure that works. The *traction motor* technology is almost a secondary *consideration*."

There are six maglev services in operation today: three in China, two in South Korea and one in Japan. None are long-distance: the longest of the six *stretches* just 30.5 kilometres between Pudong International airport and Longyang Road station in Shanghai.

The only place in the world where maglev is set to connect cities is Japan. The Chūō Shinkansen is under construction between Tokyo and Nagoya, with plans for an Osaka *extension* to be completed by 2037. This would reduce the 400-kilometre journey between Tokyo and Osaka to 67 minutes, down from 150 minutes on the bullet train. All eyes are on the project, which will show whether maglev can work on an intercity *scale*.

WHEN CITIES ALIGN

Maglev offers a green, ground-based alternative to long-distance journeys that might otherwise be taken as flights. So why is the Chūō Shinkansen the first long-distance maglev project?

For now, maglev is expensive. *Proponents* of maglev *argue* that while construction costs can be high compared with conventional high-speed rail, operating costs are low; this may well be true, but *few governments* are prepared to *pick up the bill* now.

What would a strong case for maglev look like? A maglev line should *join* two very large cities with a lot of traffic between them already, or ideally multiple very large cities, in a roughly straight line. The cities should also be hundreds of kilometres apart, otherwise maglev's *superior* speed compared with high-speed rail makes little difference.

"Where your geography has a small number of important places that are far away from each other, you can see that there would be the potential to start thinking about it," says Professor Jon Shaw, an expert in the geography of transport and the head of the School of Geography, Earth and Environmental Sciences at the University of Plymouth. The country must also have a political culture that *values* tech-

nological development and *long-term* planning. It must also, *obviously*, be *wealthy*; most governments are not in a position to *pour* tens of *billions* of dollars into a single infrastructure project. "So you've got geography, you've got culture, you've got economics," adds Shaw. "There's a *range* of things that could come together, which would provide a situation whereby maglev might be *viable*."

MAGLEV vs HIGH SPEED

Even if a country or region happens to have all three – the right geography, culture and economy for maglev – its government must be *convinced* that its advantages outweigh those offered by cheaper, more *mature* alternatives: >>>

<i>accident</i>	<i>Unfall, Unglück</i>
<i>acquisition</i>	<i>Erwerb, Ankauf</i>
<i>align, to</i>	<i>ausrichten, fluchten</i>
<i>argue, to</i>	<i>argumentieren, behaupten</i>
<i>billion</i>	<i>Milliarde</i>
<i>bin, to</i>	<i>einlagern, in den Mülleimer werfen</i>
<i>challenge</i> // 'tʃælɪndʒ	<i>Herausforderung</i>
<i>commission, to</i>	<i>beauftragen</i>
<i>consideration</i>	<i>Erwägung, Überlegung</i>
<i>convince, to</i>	<i>überzeugen, überreden</i>
<i>core</i>	<i>Kern</i>
<i>dean</i> // di:n	<i>Dekan</i>
<i>effort</i>	<i>Bestreben, Bemühung, Aufwand</i>
<i>environmental</i> // m,vairən'mentl	<i>Umwelt-, ökologisch</i>
<i>establish, to</i> // 'ɪstæblɪʃ	<i>aufbauen, schaffen</i>
<i>expertise</i> // ,ekspɜ:'ti:z	<i>Know-how, Kompetenz, Erfahrung</i>
<i>extension</i>	<i>Verlängerung</i>
<i>fatal</i> // 'feɪtl	<i>tödlich</i>

<i>government</i>	<i>Regierung</i>
<i>join, to</i>	<i>verbinden, anschließen</i>
<i>long-term</i> // ,lɒŋ 'tɜ:m	<i>langfristig</i>
<i>mature</i> // mə'tʃʊə	<i>ausgereift, vollentwickelt</i>
<i>nurture, to</i> // 'nɜ:tʃə	<i>fördern, kultivieren</i>
<i>objection</i> // əb'dʒekʃn	<i>Einwand, Widerspruch</i>
<i>obviously</i>	<i>offensichtlich, natürlich</i>
<i>pick up the bill, to</i>	<i>die Rechnung/Zeche bezahlen</i>
<i>pour, to</i>	<i>schütten, gießen</i>
<i>power supply</i>	<i>Stromversorgung</i>
<i>proponent</i> // prə'pɒnənt	<i>Befürworter/in, Verfechter/in</i>
<i>range</i> // reɪndʒ	<i>Reihe, Vielfalt, Umfang</i>
<i>scale</i>	<i>Maßstab, Dimension</i>
<i>spell the end, to</i>	<i>das Ende einleiten</i>
<i>stretch</i>	<i>Strecke, Abschnitt</i>
<i>superior</i> // su:'piəriə	<i>überlegen, besser</i>
<i>traction motor</i>	<i>Fahrmotor, Triebmotor</i>
<i>value, to</i>	<i>wertschätzen, hoch achten</i>
<i>viable</i> // 'vaɪəbl	<i>durchführbar, rentabel, tragfähig</i>
<i>wealthy</i>	<i>wohlhabend, reich</i>



The first commercial maglev service operated between 1984 and 1995 in Birmingham.

GRAMMAR BIT

LESS, FEWER, FEW, A FEW



... see **highlighted** examples in text.

If you want to express the **opposite of 'more than'**, '**less**' and '**fewer**' can be used.

'**Less**' is used with **uncountable** nouns:
less water / less money

'**Fewer**' is used with **countable** nouns:
fewer changes / fewer problems

'**Less**' can be used to **qualify an adjective**, 'fewer' cannot:
less modern / less careful

'**Few**' expresses the idea of '**not many**':
Few people believe in magic.

'**A few**' expresses the idea of '**some**':
A few of the ideas are very useful.

/// EXERCISE ON PAGE 52 ///



The maglev technology is especially popular in East Asia. The Incheon Airport Ecobee in South Korea is just one example. A few shorter lines are currently in operation in China with plans for long-distance connections.

mainly conventional high-speed rail. And conventional high-speed rail has one big, immovable advantage over maglev.

Maglev cannot integrate with existing rail infrastructure as conventional high-speed rail can; France's TGV trains, *for instance*, can run on reduced speed on older tracks, so its passengers do not need to *switch* trains as they switch tracks.

"The thing about maglev is it's obviously a brand-new system. It's completely isolated from all your existing infrastructure," says Docherty. "So it only makes economic sense if you've got enough passengers on that single route from day one. It's really important economically; you can only run maglev trains on the maglev route and you can't serve any of your existing network with it without an *interchange*."

So, while maglev operates only in East Asia today, conventional high-speed rail operates all around the world.

"To me, the world has really opened its eyes to where they want to have high-speed rail, and, more importantly, why they want it. It's about creating greener transport, alongside a *proper* integrated transport system," says Andrew Went, global high-speed rail *lead* at Arup. "It's not just high-speed rail, it has to *link* to metros ... to make it a *proper commuter*-focused strategy."

For now, maglev is too expensive and too *niche* for any governments other than that of Japan to *bet* on it over high-speed rail. However, as the Chūō Shinkansen *progresses*, governments will be watching carefully.

If the Chūō Shinkansen goes *according* to plan, China is likely to be the next country to start connecting its cities with maglev. It has the *appropriate* geographical, economic and political *circumstances* for maglev, and its government expressed an *ambition* to progress maglev systems in its 2019 transport plan. Its *R&D* efforts are quickly *bearing fruit*, allowing it to move on from importing German

<i>according, to</i>	<i>laut, gemäß, nach</i>
<i>ambition // æm'bjʌn</i>	<i>Ehrgeiz, Streben</i>
<i>appropriate</i>	<i>geeignet, entsprechend</i>
<i>bear fruit, to // beə fru:t</i>	<i>Früchte tragen</i>
<i>bet, to</i>	<i>wetten, setzen auf</i>
<i>circumstance</i>	<i>Umstand, Verhältnis, Lage</i>
<i>commuter</i>	<i>Pendler/in</i>
<i>domestic</i>	<i>heimisch, inländisch</i>
<i>for instance</i>	<i>zum Beispiel</i>
<i>interchange</i>	<i>Umstiegsmöglichkeit, Umstieg</i>
<i>lead // li:d</i>	<i>Leitung, Führung</i>
<i>link, to</i>	<i>verbinden, anschließen</i>
<i>niche // ni:ʃ</i>	<i>Nische</i>
<i>progress, to</i>	<i>sich entwickeln, vorankommen</i>
<i>proper</i>	<i>ordentlich, geeignet, richtig</i>
<i>R&D (research & development)</i>	<i>Forschung & Entwicklung</i>
<i>switch, to</i>	<i>wechseln, umsteigen</i>

maglev technology; its 18.6-kilometre Changsha Maglev Express line is its first to be built using *domestic* technology.

The future of maglev may be uncertain, but there are a few signs that it will find a home outside East Asia some time soon.

<<< Hilary Lamb >>>



Links, Vokabeln & mehr unter

www.inchbyinch.de/inch41/maglev

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www.ndr.de/geschichte/chronologie/Vor-30-Jahren-Transrapid-Hamburg-Berlin-geplant,transrapid323.html
www.tagesschau.de/ausland/asien/magnetschwebbahn-china-transrapid-100.html

Zwei aktuelle Beiträge zur Geschichte des Transrapid.

https://global.jr-central.co.jp/en/company/_pdf/superconducting_maglev.pdf

Etwas veraltete Informationsbroschüre von JR Central über den Chuo Shinkansen.

www.jrailpass.com/blog/chuo-shinkansen-maglev

Aktuellerer Beitrag über den Chuo Shinkansen.

TECH EXTRAS

HOW MAGNETIC LEVITATION WORKS

MINI DICTIONARY

RAIL ENGINEERING

<i>automatic train stop</i>	<i>Zwangsbremmung</i>
<i>baggage compartment</i>	<i>Gepäckabteil</i>
<i>brake sign</i>	<i>Bremszeichen</i>
<i>car sequence</i>	<i>Wagenreihung</i>
<i>conductor rail BE</i>	<i>Stromschiene</i>
<i>destination coach</i>	<i>Kurswagen</i>
<i>dining car</i>	<i>Speisewagen</i>
<i>emergency brake</i>	<i>Notbremse</i>
<i>front BE</i>	<i>Zugspitze</i>
<i>gondola AE</i>	<i>offener Güterwagen</i>
<i>head end AE</i>	<i>Zugspitze</i>
<i>light running</i>	<i>Leerfahrt</i>
<i>loop BE</i>	<i>Abstellgleis</i>
<i>main line traffic</i>	<i>Fernverkehr</i>
<i>open wagon BE</i>	<i>offener Güterwagen</i>
<i>platform</i>	<i>Bahnsteig</i>
<i>power car</i>	<i>Triebkopf</i>
<i>power rail AE</i>	<i>Stromschiene</i>
<i>proceed signal</i>	<i>Fahrtsignal</i>
<i>rack (and pinion) railroad</i>	<i>Zahnradbahn</i>
<i>reverse curve</i>	<i>Kehrschleife</i>
<i>road vehicle loading ramp</i>	<i>Autoverladerampe</i>
<i>scotch block BE</i>	<i>Radvorleger</i>
<i>siding AE</i>	<i>Abstellgleis</i>
<i>skate AE</i>	<i>Radvorleger</i>

Maglev trains don't have wheels or *rails*, instead they rely on magnets to *float* down *guideways* without ever touching them. *Levitation*, *propulsion* and *guidance* are the three essential parts of maglev functionality.

To *suspend* the train above the track, Electromagnetic Suspension (EMS) uses the *attractive* force of electromagnets placed on the guideway and on the train. While EMS is easy to implement and *maintains* levitation at zero speed it's also *inherently* unstable and *requires* a complex feedback-control system. Especially at high speeds, it becomes difficult to maintain the correct distance between train and guideway.

Electrodynamic Suspension (EDS), in contrast, uses the *repulsive* force of *superconducting* magnets placed on the guideway and on the train to *achieve* levitation. Stability at high speeds is excellent but there's a minimum speed required for the train to *levitate* at all. The necessary supercooling is complex and costly.

Both systems use linear motors for propulsion. Instead of a rotating magnetic field, like in rotary motors, the stator of a linear motor generates a field that travels down its length and pulls it down the stator.

<i>achieve, to // ə'tʃi:v</i>	<i>erreichen, erzielen</i>
<i>attractive</i>	<i>anziehend</i>
<i>float, to</i>	<i>schweben, gleiten</i>
<i>guidance</i>	<i>Führung</i>
<i>guideway</i>	<i>Führung, Führungsnut</i>
<i>inherently // m'herəntli</i>	<i>von Natur aus, grundsätzlich</i>
<i>levitate, to</i>	<i>schweben</i>
<i>levitation</i>	<i>Schweben</i>
<i>maintain, to</i>	<i>erhalten, bewahren</i>
<i>propulsion</i>	<i>Antrieb, Vortrieb</i>
<i>rail</i>	<i>Schiene, Gleis</i>
<i>repulsive</i>	<i>abstoßend</i>
<i>require, to</i>	<i>erfordern, benötigen</i>
<i>superconducting</i>	<i>supraleitend</i>
<i>suspend, to</i>	<i>aufhängen, i. d. Schwebelassen</i>
<i>suspension</i>	<i>Aufhängung</i>

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

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

 Hello, I have a **room booked** in the name of Conolly.

 Good afternoon Mr Conolly. **Let me see.** Ah, yes, a single room for 2 nights.

 That's right. I might need to **stay an extra night.** Would that be OK?

 **Yes, it shouldn't be a problem.** B: Could you please **fill out** the registration form?

 I'd also like to park in the underground car park. How do I **gain access?**

 Write your car's **number plate** on the form. I'll enter it in the computer and it will be read by cameras upon entry and exit, and the barrier raises automatically.

 Sounds good. I know it's late for lunch, but is the restaurant still open?

 **Unfortunately,** the restaurant is closed, but there is a café nearby. Just turn right outside the hotel and **you will see it.**

 That's fine.

 Here's your key card. You have room 428 on the fourth floor. The lift is just over there.

 I have a very early start in the morning. **What time is breakfast?**

 From 7 o'clock. But if you need anything earlier than that, then I can arrange for room service.

 That should be fine. I need to be in the city centre by 8 a.m. Is that far from here?

 **To walk there,** it takes about 15 minutes. By taxi it's only around five minutes.

 Great. Thanks for your help.

 **My pleasure.** Have a good day sir.

- A that should be fine.
- B extend that by a day
- C get in and out
- D when does the dining room open
- E I'm afraid
- F registration

- G on foot
- H all part of the service
- I reservation
- J complete
- K just a moment
- L can't miss it

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 find examples in the text of verb forms that correspond to the explanation in the right column (there are sometimes more than one example):

Zalando SE is a German multinational E-commerce company based in Berlin. The headquarters are located in Berlin and right now it (1) _____ (is having/has/have) offices, called tech hubs, in several countries around Europe. The company (2) _____ (operated/is operating/operates) a platform offering fashion and lifestyle products to customers in 23 European markets.

Zalando (3) _____ (was founded/found/was found) in 2008 by Robert Gentz and David Schneider together with Rocket Internet. Inspired by US online retailer Zappos.com, Zalando *initially* (4) _____ (was specialized/specialized/had specialized) in the sale of footwear. By 2012 it (5) _____ (was opening/opened/had opened) online *retail* stores in more than 10 European countries.

Following examples of tech companies from the East, especially China, Zalando (6) _____ (is operating/has been operating/was operating) as a European digital platform since 2013. From the very beginning, Zalando (7) _____ (was aiming/had aimed/aimed) to remake itself into a digital *shopping mall*, allowing fashion houses and *retailers* to make sales via the Partner Program, often with only limited input from Zalando. Now, of course, this is reality.

One major milestone was in the year 2014 when Zalando (8) _____ (was listed/listed/has been listed) on the Frankfurt Stock Exchange. After the share price fell quite dramatically between the initial *issue* and 2015 it stabilised over the years that followed and (9) _____ (is/has been/will be) a member of the DAX since 2021.

Right now the company (10) _____ (leads/has led/is leading) the way in promoting *sustainable* fashion and by the end of 2025 they hope they (11) _____ (will have reduced/will reduce/are going to reduce) emissions by 80%. On top of that, in the course of the next two years they (12) _____ (phase out/will phase out/are phasing out) single-use plastic packaging completely.

- A _____ something that happened before and up to another point in the past
- B _____ a simple action in the future
- C _____ an action at a specific time in the past (in the passive)
- D _____ an action finished before or at a certain point in the future
- E _____ a general fact about a company and/or its business
- F _____ something that started in the past and is still going on
- G _____ something happening right now
- H _____ an action at a specific time in the past

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

<i>found, to</i>	<i>gründen</i>
<i>initially // ɪˈnɪʃəli</i>	<i>anfänglich</i>
<i>issue // ˈɪʃuː</i>	<i>Emission (Börse)</i>
<i>phase out, to</i>	<i>schrittweise beendigen</i>
<i>retail</i>	<i>Einzelhandel</i>
<i>retailers</i>	<i>Einzelhändler</i>
<i>shopping mall</i>	<i>Einkaufszentrum</i>
<i>sustainable // səˈsteɪnəbl</i>	<i>nachhaltig</i>

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 ////

unit	1	What a customer pays for one item.
unit	2	What a producer pays to produce one item.
unit	3	Part of an injection system in an engine cylinder.
unit	4	How heavy one item is.

standard price power air-conditioning heating organizational cost matrix
storage pump military control monetary kitchen weight intensive-care

This regulates the temperature in a room, for example.	5	unit
A radiator, for example.	6	unit
This directs the operation of a processor in a CPU, for example.	7	unit
You'll find seriously ill patients here.	8	unit

room	1	You need this in a hotel to access where you sleep.
room	2	What you have to pay for accommodation.
room	3	Usually around 20 to 25°C.
room	4	You order this if you don't want to leave your hotel accommodation.

back single key staff number temperature control service
lighting fitness locker stock mate rate boiler engine

Where you might find a large container for heating water. Maybe in the basement?	5	room
The centre of operations.	6	room
A small warehouse.	7	room
You get changed here before and after doing sports.	8	room

THE MANUAL

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

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

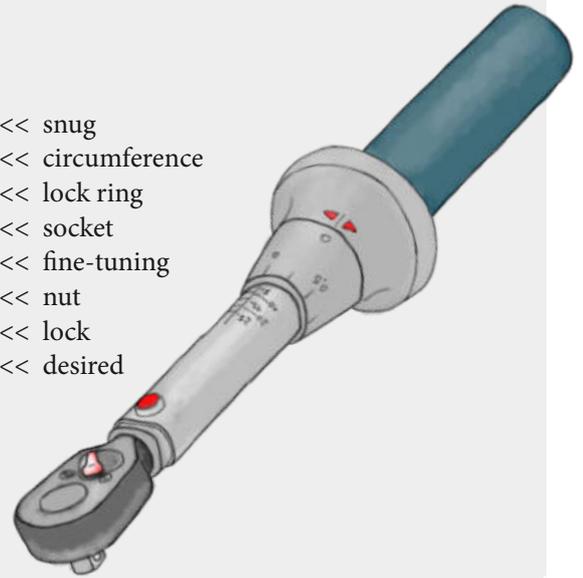
TORQUE WRENCH

Setting the Torque

Unlock the safety locking by pulling the _____ on the handle into the 'unlocked' position. Turn the handle until the top edge of the handle lines up with the nearest value below the _____ torque on the scale. Be aware that the scale is in ft-lbs on one side of the torque wrench and Nm on the other side. At the end of the handle there is a secondary _____ torque scale ranging from 0 to 4 around the _____ of the handle. The value of this scale is added to the value shown just above the handle. Make sure the lock ring is in the locked position after you have finished setting the torque value.

Install the required _____ to the square drive and tighten the _____ or bolt slowing to a smooth, steady pull as the nut or bolt becomes _____. When the wrench clicks, the torque setting has been reached. Do not continue to pull after the torque setting is reached. After every use, set to the lowest torque setting and _____ the wrench.

- << snug
- << circumference
- << lock ring
- << socket
- << fine-tuning
- << nut
- << lock
- << desired



HOT GLUE GUN

General Operation

Turn on the glue gun by _____ it into a mains powered outlet. Insert a _____ into the gun through the feeder tube and allow the glue gun to heat up for approximately five minutes before use. Squeeze the trigger a few times to further load the stick into the gun until you feel a slight _____.

The hot glue gun is now ready for use. Hold the _____ against the surface to be glued and press the flow control trigger to _____ glue. The trigger may require several operations before the glue starts to flow. Between gluing operations the glue gun can be rested on the _____. Be aware that glue might _____ after operation and ensure the surface the glue gun is placed upon can handle the heat and is not damaged by the glue.

Caution: If your skin comes into contact with the nozzle or hot glue a serious burn may occur. Hot melt glue should not be used in place of a structural fastener, to hold heavy loads nor in any _____ that will be exposed to heat.



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

application	Anwendung
circumference // sə'kʌmfərəns	Umfang
deposit, to // dɪ'pɒzɪt	hier: auftragen
desired	erwünscht
drip, to	tropfen
fine-tuning	Feinabstimmung
glue stick	Klebestift
lock ring	Sicherungsring

lock, to	sichern
nozzle // 'nɒzl	Düse
nut	Schraubenmutter
plug, to	einstecken
resistance // rɪ'zɪstəns	Widerstand
snug	feststehend
socket	Steckschlüsseleinsatz
support bracket	Aufstellbügel

HISTORY



Der Eiffelturm ist eigentlich gar nicht Eiffels Turm: Er wurde vom Wind geformt, von einem Schweizer geplant und berechnet, von einem Architekten verziert und er entstand in einem Kampf zwischen einem Mast und einem Leuchtturm. Das ist die Geschichte eines Wunders der Ingenieurskunst, das zu einem nationalen Symbol wurde.

< PHOTOS: LOUIS-ÉMILE DURANDELLE >

THE PYLON OF PARIS

The Eiffel tower isn't actually Eiffel's tower: It was shaped by the wind, planned and calculated by a Swiss engineer, embellished by an architect and forged in a battle between a pylon and a lighthouse. This is the story of an engineering marvel that became a national icon.

“Non!” Gustave Eiffel didn't like the tower.

Just before this, the French *government* had announced they would *host* another 'Exposition Universelle' in 1889. To mark the 100th *anniversary* of the French revolution they were now looking for a 'clou', an equally revolutionary structure as the centrepiece of the world's *fair* in Paris. For Maurice Koechlin, head of the engineering *department* in Eiffel's metal construction and *public works* company, this clou could only be a tower that reached the symbolic height of a 1,000 feet or 300 metres. The Swiss engineer talked to his colleague, the technical director Émile Nouguier, who liked a *challenge*, and together they started designing a giant metal pylon.

But when the two finally presented their side project to their boss, Eiffel, he wasn't *intrigued*. Sure, 300 metres was *highly ambitious* and the engineering certainly was *sound* – after all, Koechlin had done the calculations for some of the firm's most *prestigious* projects such as the Duoro bridge near Porto or the inner *framework* for the Statue of Liberty in New York. Nouguier, too, was an excellent engineer and expert in *assembly* and site management. What Eiffel disliked was that their design was somewhat *utilitarian*, too much a structural pylon without any of the *grandeur* demanded by the event.

At least the two engineers had made enough of an impression not to be called off the project. Eiffel had a feeling that

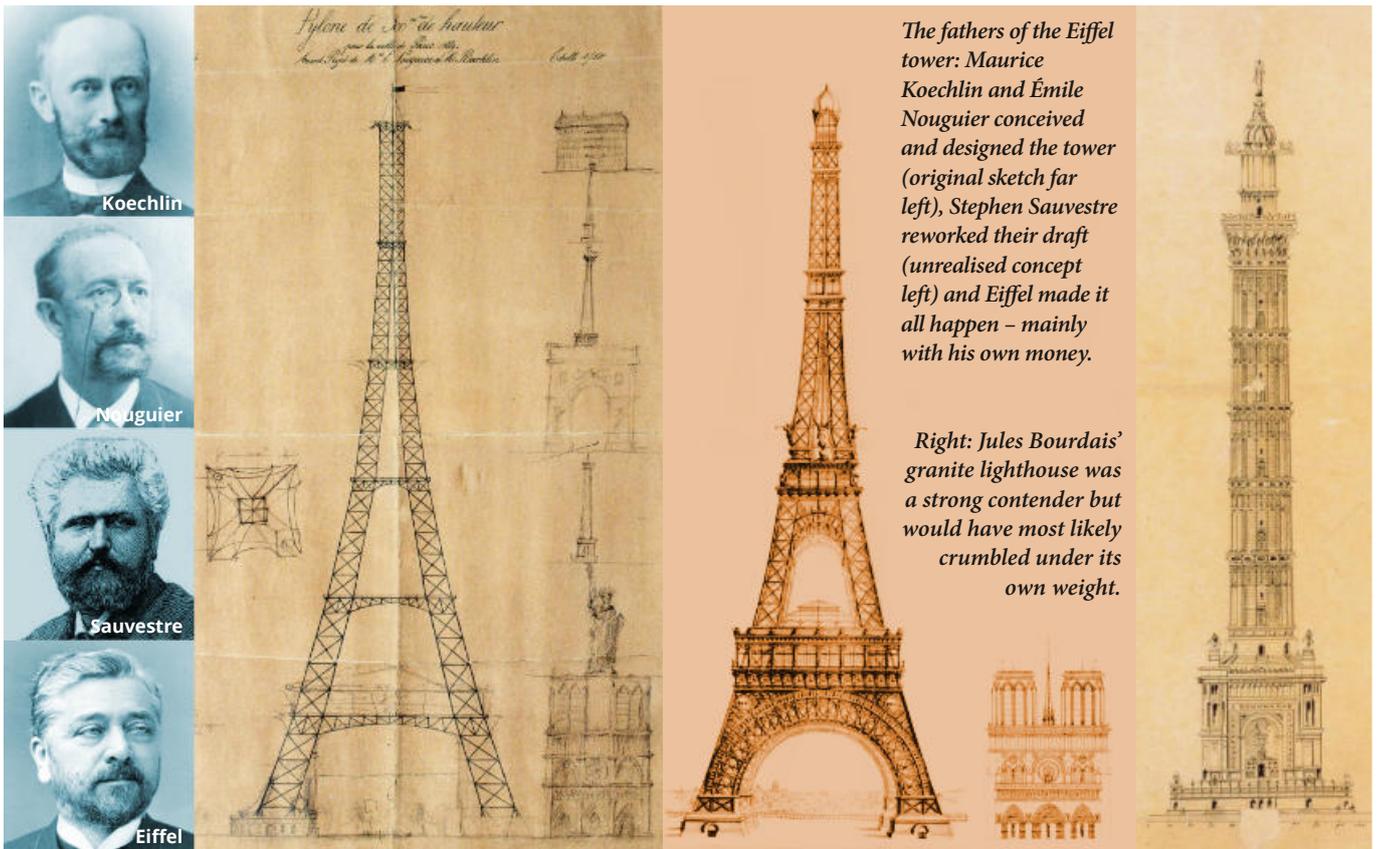
they were on to something and, quite *literally*, sent them back to the drawing board. So Koechlin and Nouguier asked another colleague, the architect Stephen Sauvestre, for help. Sauvestre reviewed the project with a fresh and, above all, aesthetically trained eye and *suggested* a few *alterations*: He reduced the number of platforms from four to three, added a *bulb-shaped cupola* to the top to make it more *pronounced*, *proposed* a *huge* glass pavilion at the first level, *dressed* the legs with stonework *pedestals* and included all sorts of *embellishments* – most prominently the giant *arches* below the first platform, which added to the solidity of the base and turned the tower into an entrance gate to the *exhibition*.

Yet, the tower's most prominent feature, its elegant curved *taper* towards the top, wasn't designed by Sauvestre nor the two engineers but by nature itself. In tall buildings the wind *resistance* adds a *considerable amount* of *lateral* force to the usual vertical load from the building's own weight – something Koechlin was well aware of from his *previous* projects. To balance the forces of wind and weight, Koechlin used graphostatic methods which kept the math *involved* to a minimum and resulted in the iconic shape.

A tower shaped by the wind, with elegant architectural details and solid engineering – Eiffel *finally* was pleased. So much so that, in September 1884, he *filed a patent* for “a >>>

<i>alteration</i>	Änderung, Anpassung
<i>ambitious</i>	ehrgeizig, anspruchsvoll
<i>amount</i>	Menge, Betrag, Umfang
<i>anniversary</i>	Jubiläum, Jahrestag
<i>arch</i> // ɑ:tʃ	Bogen
<i>assembly</i>	Montage, Zusammenbau
<i>bulb</i>	Kolben, Birne
<i>challenge</i> // 'tʃælɪndʒ	Herausforderung
<i>considerable</i>	beachtlich, beträchtlich
<i>cupola</i> // 'kju:pələ	Kuppel
<i>demand, to</i>	fordern, verlangen
<i>department</i>	Abteilung, Fachbereich
<i>dress, to</i>	verkleiden, dekorieren
<i>embellish, to</i> // ɪm'belɪʃ	verzieren, verschönern
<i>embellishment</i> // ɪm'belɪʃmənt	Ausschmückung, Verzierung
<i>exhibition</i>	Ausstellung, Messe
<i>fair</i>	Messe
<i>file a patent, to</i>	ein Patent anmelden
<i>forge, to</i> // fɔ:dʒ	schmieden
<i>framework</i>	Gerüst, Gestell

<i>government</i>	Regierung
<i>grandeur</i>	Erhabenheit, Prunk
<i>host, to</i> // həʊst	ausrichten, veranstalten
<i>huge</i> // hju:dʒ	riesig, enorm
<i>intrigue, to</i> // ɪn'tri:g	interessieren, faszinieren
<i>involve, to</i>	beinhalten, erfordern
<i>lateral</i>	seitlich, quer-
<i>marvel</i>	Wunder
<i>pedestal</i>	Sockel, Podest
<i>prestigious</i> // pre'stɪdʒəs	namhaft, renommiert
<i>previous</i>	vorherige/r/s, bisherige/r/s
<i>pronounced</i>	ausgeprägt, markant
<i>propose, to</i>	vorschlagen, anregen
<i>public works</i>	öffentliche Bauvorhaben
<i>pylon</i> // 'paɪlən	Mast
<i>resistance</i>	Widerstand
<i>sound</i>	hier: solide, fundiert
<i>suggest, to</i> // sə'dʒest	vorschlagen, empfehlen
<i>taper</i> // 'teɪpə	Verjüngung, Abschrägung
<i>utilitarian</i> // ju:'tɪl'ɪtəriən	zweckmäßig



The fathers of the Eiffel tower: Maurice Koechlin and Émile Nougier conceived and designed the tower (original sketch far left), Stephen Sauvestre reworked their draft (unrealised concept left) and Eiffel made it all happen – mainly with his own money.

Right: Jules Bourdais' granite lighthouse was a strong contender but would have most likely crumbled under its own weight.

new configuration allowing the construction of metal *supports* and pylons capable of *exceeding* a height of 300 metres". While Koechlin, Nougier and Sauvestre were *mentioned* in the patent Eiffel was quick to buy all their rights for one percent on all the amounts which would be paid to him for the construction of the tower if the project was accepted. What once was a plain 300-meter-tall pylon had finally become Eiffel's tower. Now he only had to find a way to build it.

THE TWO TOWERS

The exhibition committee had already *pondered* the idea of a tall structure; after all, they were somewhat of a world fair tradition: The Latting Observatory, a 96-meter-tall wooden *lattice* tower, was part of the 1853 expo in New York City, and in 1876 a 1000-foot-tall *Centennial* Tower should have been the highlight of the Philadelphia expo but was never realised. So, in 1886, the French committee called a *competition* for a tower in Paris. With some clever lobby work Eiffel was able to ensure that the *call for tender* was more or less a *carbon copy* of his patent filing asking "to raise an iron tower on the Champ-de-Mars with a square base 125 metres across and 300 metres tall".

Winning the competition, however, turned out to be not as *straightforward* as Eiffel had hoped. The committee was flooded with hundreds of *submissions*, ranging from the *ridiculous*, such as a giant watering can "to bring *relief* from *sultry* days" to the grotesque in the form of a giant Guillotine to *honour* the *victims* of the French revolution.

Eiffel's most serious *competitor* was Jules Bourdais, one of the architects of the famous Trocadéro Palace built for the 1878 Exposition Universelle. Bourdais had joined with engineer Amédée Sébillot to propose a "Colonne Soleil". Their sun *column* was basically a glorified lighthouse: It had a *triangular* base which already was taller than nearby Notre Dame. On top was a giant *pillar* crowned by a "solar lantern", a set of *arch lamps* which, with the help of parabolic reflectors mounted on nearby buildings, would be able to illuminate every corner of Paris.

The two leading designs couldn't have been more different: a precisely calculated construction versus a *lavish* architectural monument. Modernity versus tradition. The *upstart* engineer versus the *established* architect. Metal versus stone. Ultimately, it was the choice of material which decided the battle of the two towers. After much *deliberation*, the committee *doubted* that, at the projected height, a tower made of granite could *support* its own weight. It didn't help that Bourdais was also rather vague concerning the *foundation* of his tower. Eiffel, on the other hand, had already *factored in* deep foundations and picked his material *carefully*. He knew that *cast iron*, often considered for previous *attempts* to build a tall tower, was too *brittle* and *lacked tensile strength*. Like stone, cast iron was suitable only when *subjected* to compressive loads such as in arches and columns. Steel, which thanks to the Bessemer process *invented* in 1856 had become much cheaper, would have been the *obvious* choice, but Eiffel was afraid that the material's high elasticity would lead to

considerable *sway* at the top of the tower. In the end he *settled on wrought iron*, a material he had lots of *experience* with. It was strong, *rigid* and easy to work with.

After endless hearings and discussion Eiffel was able to convince the committee of his design and on January 8, 1887, the agreement for the construction and operation of the tower was finally signed. By then, time was running short. The expo would open on May 6, 1889, which left Eiffel with a little over two years to actually build his tower. 849 days to erect the tallest structure in the world by far – in fact, the Eiffel Tower

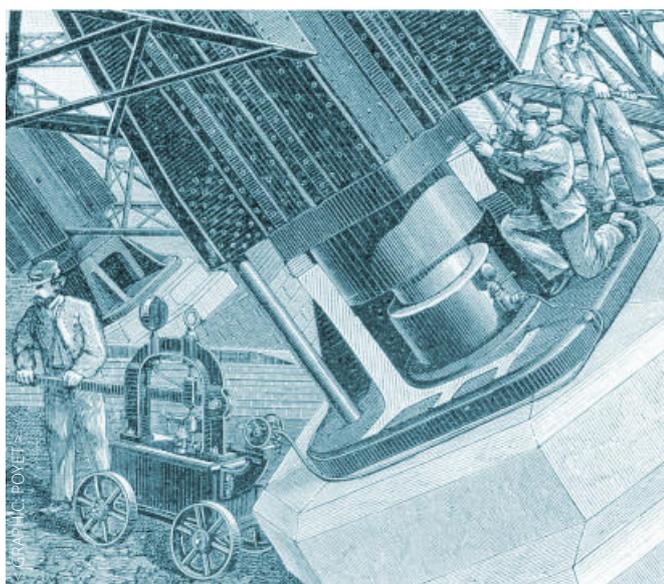
would be almost twice as tall as the record holders at the time, the Washington Monument and the Cologne Cathedral, the *latter* of which took 632 years to be completed.

A MAZE OF LATTICE BEAMS

Just three weeks after the contract had been signed, work on the 15-meter-deep foundations for the legs started. Since two of them were near the Seine and reached below the river's level Eiffel was forced to use *pneumatic caissons* for the *excavation*, a technique he was familiar with from his bridge work. >>>

<i>arch lamp</i> // ɑ:tʃ læmp	Bogenlampe
<i>attempt</i>	Versuch, Anlauf
<i>brittle</i>	spröde, brüchig
<i>call for tender</i>	Ausschreibung
<i>carbon copy</i>	(identische) Kopie, Durchschlag
<i>cast iron</i>	Gusseisen, Grauguss
<i>centennial</i> // sen'teniəl	Hundertjahrfeier
<i>column</i>	Säule, Pfeiler
<i>competition</i>	Wettbewerb, Auswahlverfahren
<i>competitor</i>	Konkurrent/in, Wettbewerber/in
<i>deliberation</i> // dɪ,lɪbə'reɪʃn	Überlegung, Beratung
<i>doubt, to</i> // daʊt	zweifeln, bezweifeln
<i>established</i> // ɪ'stæblɪʃt	etabliert, bekannt
<i>excavation</i> // ,ɛkskə'veɪʃn	Aushub, Baugrube
<i>exceed, to</i>	übersteigen, übertreffen
<i>experience</i> // ɪk'spɪəriəns	Erfahrung, Praxis
<i>factor in, to</i>	einkalkulieren, berücksichtigen
<i>foundation</i>	Fundament
<i>honour, to</i>	ehren
<i>invent, to</i>	erfinden, ausdenken
<i>lack, to</i>	nicht haben, mangeln
<i>lantern</i> // 'læntən	Laterne
<i>latter</i>	letztere/r/s
<i>lattice</i> // 'lætlɪs	Gitter (-werk), Fachwerk

<i>lattice beam</i> // 'lætlɪs bi:m	Gitterträger
<i>lavish</i>	üppig, opulent, prunkvoll
<i>maze</i> // meɪz	Irrgarten
<i>mention, to</i> // 'menʃn	erwähnen, nennen
<i>obvious</i>	offensichtlich, augenscheinlich
<i>pillar</i>	Säule, Pfosten
<i>pneumatic caisson</i> // 'keɪsn	Druckluftsenkkasten
<i>ponder, to</i>	überlegen, nachdenken
<i>relief</i> // rɪ'li:f	Erleichterung, Linderung
<i>ridiculous</i>	lächerlich, absurd
<i>rigid</i> // 'rɪdʒɪd	starr, fest
<i>settle on, to</i>	sich entscheiden für
<i>straightforward</i>	unkompliziert, einfach
<i>subject to, to</i>	unterziehen
<i>submission</i>	Einreichung, Angebot
<i>sultry</i> // 'sʌltri	schwül, drückend
<i>support</i>	Stütze, Unterlage
<i>support, to</i>	tragen, stützen
<i>sway, to</i>	schwanken, schaukeln
<i>tensile strength</i>	Zugfestigkeit
<i>triangular</i> // traɪ'æŋɡjələ	dreieckig
<i>upstart</i>	Emporkömmling
<i>victim</i>	Opfer
<i>wrought iron</i> // ,rɔ:t 'aɪən	Schmiedeeisen



How do you straighten the tallest tower in the world? Eiffel used 16 large pneumatic cylinders which were integrated into the base of the columns of each leg.

GRAMMAR BIT

ADVERBS (SPELLING)



... see highlighted examples in text.

He's a quick driver. // **'quick'** describes the driver (**adjective**)

He drives quickly. // **'quickly'** describes **how** the driver does something (**adverb**)

To make an adverb from an adjective, we simply add -ly:
slow – slowly / bright – brightly

If the adjective ends in an '-l', we need to doubly the 'l':
usual – usually / final – finally

If the adjective ends in a '-y', we need to add '-ily':
steady – steadily / easy – easily (exception: shy / shyly)

If the adjective ends in '-le', we drop the '-e' and add '-ly':
simple – simply / responsible – responsibly

If the adjective ends in only '-e', then we simply add '-ly':
relative – relatively / ultimate – ultimately

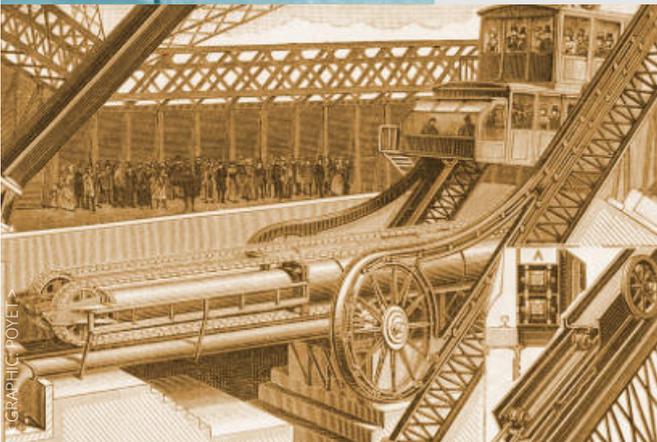
/// EXERCISE ON PAGE 52 ///



< PHOTO: AGENCE MEURISSE >

Left: On the 31st March, 1889, one month before the opening of the world fair, workers put the finishing touches to the arches at the top of the Eiffel tower.

Below: The elevators were operated by giant hydraulic cylinders. During construction the tracks of these elevators were used for mobile cranes.



GRAPHIC: POYET

After five months the first iron *frameworks* were installed. The main structure of the tower is *composed* of four legs with 28 *distinct* tiers. The legs are connected by two platforms, one at the 5th tier, or 58 metres, and one at the 11th tier, or 116 metres. Above that, the four legs *merge* into a single pylon. Each tier consists of four *riveted box columns* at the corners interconnected by horizontal lattice beams and *heavily cross braced* with diagonal lattice beams.

Beams and columns were pre-fabricated at Eiffel's factory in Levallois-Perret, then at the outskirts of Paris, and transported to the Champ-de-Mars. Here they were *assembled* into larger units, held together first by *bolts* before being lifted into place and riveted together with a total of 2,500,000 *rivets* by a workforce of *merely* 250 men.

Eiffel took great *pride* in the fact that his large bridges were built without the need for any *falsework* or supporting *scaffold* but *due* to their large *inclination* at the base, the legs of the tower had to be held up with large wooden *props*. This, however, caused a delicate balancing act. For one, the legs had to meet at exactly the right place to connect to the platform, which was also held up by a giant wooden support. In addition to that, it was *crucial* that each leg and each of its four box columns carried the same load. To *accomplish* this, the part connecting the box columns to the foundation had built-in hydraulic cylinders so that the columns could be lifted with a hydraulic pump and metal *shims* could be inserted. Eiffel also had sand boxes installed at the top of the wooden props so that the overhanging legs weren't *resting* directly on the wood but on a bed of fine, dry sand. This way the legs could be adjusted with millimetre precision *simply* by *trickling* out sand through a hole at the bottom of the box.

Since the tower would be the tallest structure in the world there was, by definition, no crane tall enough to build it. Eiffel's *solution* to this *conundrum* was simple: Let the

accomplish, to	erreichen, bewerkstelligen
assemble, to	montieren, zusammenbauen
bolt	Schraube, Bolzen
box column	Rechtecksäule
composed of, to be	bestehen aus
construction elevator	Bauaufzug
contemporary	zeitgenössisch, aktuell
conundrum // kə'naʊdrəm	Rätsel, Problem
crawl, to	kriechen
cross brace, to	querverstreben
crucial // 'kru:ʃl	wichtig, kritisch, essentiell
daring // 'deəriŋ	waghalsig, tollkühn
distinct	ausgeprägt, eindeutig, einzeln
due to // dju: tə	aufgrund von, wegen
falsework	Lehrgerüst, Traggerüst
fatality	Todesfall
folly	Torheit, Aberwitz
framework	Fachwerk, Rahmenwerk
funicular // fju:'nikjələ	Standseilbahn, Bergbahn
hoist, to	hochziehen, anheben
inaugurate, to // i'no:gjəreɪt	einweihen, eröffnen

inclination	Neigung, Schrägstellung
ingenuity // ɪndʒə'nju:əti	Einfallsreichtum, Findigkeit
merely // 'mɪəli	lediglich, bloß, nur
merge, to // mɜ:dʒ	ineinander übergehen
novel // 'nɒvl	neuartig
pioneer, to	Pionierarbeit leisten, vorbereiten
pride	Stolz
prop	Stütze
put to shame, to	beschämen
rest, to	ruhen, liegen
reward // rɪ'wɔ:d	Belohnung, Lohn
rivet	Niete
rivet, to	nieten, vernieten
scaffold // 'skæfəʊld	Gerüst
shim	Unterlegplatte, Ausgleichsstück
solution // sə'lju:ʃn	Lösung
tier // tiə	Ebene, Etage
track	Gleis, Schiene
trickle, to	hier: rinnen, rieseln
ungainly	plump, unschön
yet	noch

crane assemble itself. Once the tower was finished, four *funicular*-like hydraulic lifts, one in each leg, would carry visitors to the first and second level from where a single hydraulic lift carried them on to the top. During the building phase, however, the *tracks* of these lifts were used for mobile cranes, which not only *hoisted* the various tower segments but also their own tracks on which they would *steadily crawl* upwards – a system not unlike the way modern-day *construction elevators* are assembled.

Eiffel's *ingenuity* and construction site management *puts* many modern day projects *to shame*. Not only did he *pioneer* many *novel* construction methods, some of which are still in use today; he also completed the *daring* and risky build without any *fatalities*. Most surprisingly, however, he finished a month early. The Eiffel Tower was *inaugurated* on March 31, 1889. *Unfortunately*, the elevators weren't *yet* working and so all the officials had to climb 1,710 steps to get to the top. A breathtaking exercise – just as their *reward*: an equally breathtaking view over Paris.

While the Eiffel tower is certainly the greatest 'clou' of any 'Exposition Universelle' before and after Paris 1889, it wasn't universally liked at first. Many Parisians, including a long list of *contemporary* artists, said "Non!" and called it

"Eiffel's folly", "*ungainly* skeleton", "half-built factory pipe" or worse. *Luckily*, most of them changed their mind – *usually* about half way up the elevator to the top of the Eiffel tower.

<<< Matthias Meier >>>

www.toureffel.paris/en/the-monument

Offizielle Webseite des Eiffelturms mit vielen Informationen zu dessen Bau und Geschichte.

https://artsandculture.google.com/story/the-construction-of-the-eiffel-tower/UgWBglpOORsA8A

Bildreiche Google Arts & Culture Seite über den Bau des Eiffelturms.

www.arthurchandler.com/paris-1889-exposition

www.historytoday.com/archive/eiffels-tower

https://wondersofworldengineering.com/eiffel_tower.html

Drei etwas ausführlichere Webseiten über die Entstehung des Eiffelturms.

https://trako.arch.rwth-aachen.de/cms/trako/forschung/

bautechnikgeschichte/~mmso/maurice-koechlin-der-eigentliche-erfin

Artikel über den Beitrag des Schweizer Maurice Koechlin, den ursprünglichen Konstrukteurs des Eiffelturms.

https://gallica.bnf.fr/ark:/12148/btv1b11600084/f79.item

Eiffels Buch über „La tour de trois cents mètres“ im französischen Original.

https://catalog.princeton.edu/catalog/99103509383506421#view

53 Aufnahmen vom Bau des Eiffelturms fotografiert von Louis-Émile Durandelle.

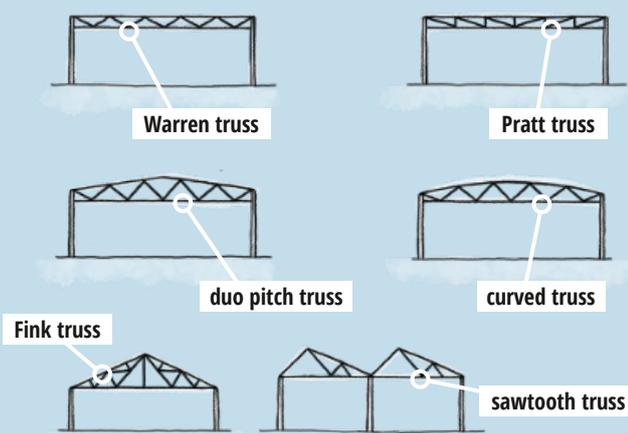


Links, Vokabeln & mehr unter

www.inchbyinch.de/inch41/eiffel

TECH EXTRAS

PICTORIAL LATTICE TRUSS



access, to // 'ækses	betreten
airlock	Druck-, Luftschleuse
avoid, to	vermeiden, umgehen
chamber // 'tʃembə	Kammer, Raum
complain, to	sich beschweren, klagen
concrete // 'kɒŋkri:t	Beton
consist of, to	bestehen aus
disease // dɪ'zi:z	Krankheit
foundation	Fundament

HOW PNEUMATIC CAISSONS WORK

Pneumatic caissons are used for underwater constructions such as *foundations* for bridges, piers, dams or buildings near the water. They *consist of* a large box or cylinder-like structure usually made from *reinforced concrete* with an airtight working *chamber* at the bottom. Similar to pressing an empty cup upside down under water, the pneumatic caisson is lowered onto the bed of the water body and the working chamber is *pressurized* to *prevent* water from entering. Workers can then *access* the chamber through an *airlock* and work in relatively dry conditions.

When pneumatic caissons were introduced workers often *suffered* from the "caisson disease" *complaining* about pain in the *joints* and worse. To *avoid* the symptoms of what is today known as "decompression sickness" workers in pneumatic caissons had to spend extra time in a decompression chamber after their *shift*.

joint	Gelenk
pneumatic caisson // nju:,mætɪk 'keɪsn	Druckluftsenkkasten
pressurize, to	mit Druck beaufschlagen
prevent, to	verhindern, vermeiden
reinforced // ,ri:ɪn'fɔ:st	bewehrt
shift	Schicht
sickness	Krankheit
suffer, to	erleiden

FILL THE GAPS

>>> WHERE IN THE WORLD IS MAGLEV // 36

Fill the gaps with **less**, **fewer**, **few** or **a few**.

- 1 Retro-fitting a ship with a wind propulsion technology is often [] effective than designing a hybrid vessel from scratch.
- 2 There were [] prototypes of the new transport ship before the current version took to the seas.
- 3 The latest submersible vessel is small; it takes up [] space than two jet-skis stored side-by-side.
- 4 The new submarine has been used on [] research missions, but is mainly used for leisure trips.
- 5 The architect Sauvestre reviewed Eiffel's project and he suggested [] alterations: he suggested [] platform levels, three instead of four.
- 6 Maglev trains have several advantages: they cannot be defeated by ice or leaves on their tracks; [] maintenance is required (no wheels to wear down tracks and [] moving parts to malfunction overall); and they are [] noisy than conventional railways.
- 7 There have been [] experiments with Maglev trains all around the world, but most failed. The system is expensive and [] governments are prepared to spend so much money in these hard times.
- 8 The future of maglev may be uncertain, but there are [] signs that it will find a home outside East Asia some time soon.
- 9 We have a flat hierarchy with [] regulations and [] supervision.
- 10 [] people realise how difficult the job of an influencer can be; it just looks so easy.

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

CHANGE

>>> THE PYLON OF PARIS // 46

The words in bold have to be changed into adverbs. Decide how you would spell them. Be careful, there are four which don't need to be changed.

- 1 Four large, **full** [] automatic vertical wings **significant** [] reduce the fuel consumption of the hybrid vessel.
- 2 The custom-built ship Canopée is a RORO cargo ship which could **easy** [] be mistaken for just an **ordinary** [] transport vessel; but has four giant masts with wing-like sails.
- 3 In 2018, they issued a call for tenders for a competitive and **environmental** []-friendly logistics solution.
- 4 As a result, the effectiveness of wind propulsion depends **heavy** [] on the design of the vessel and its operational practices.
- 5 The first **commercial** [] maglev service opened in 1984. It was **simple** [] called Maglev and it shuttled passengers between Birmingham airport and Birmingham International station.
- 6 Introducing maglev is a big decision. It's **real** [] important **economic** [] ; you can't combine maglev with existing railways, so it is very **expensive** [] .
- 7 China is **like** [] to be the next country to start connecting its cities with maglev.
- 8 **Normal** [] , with a big project you get a long list of compliance requirements.
- 9 The first design of the tower was **basic** [] a glorified lighthouse.
- 10 The two leading designs for the Eiffel Tower were very different: a **precise** [] calculated construction versus a lavish **architectural** [] monument. **Ultimate** [] , it was the choice of material which decided the battle of the two towers.

JUMBLLED WORDS

>>> SAILING TO SPACE // 6

Find the word which is described by unjumbling the letters. The first letter is always the first letter in the word.

1 A E R A E A P C P N

A

the way something or someone looks

2 C I G L N E G H N L A

C

testing ones abilities; demanding

3 E R I E S T X E P

E

skill or knowledge in a particular field

4 D A O V N I I E T

D

the amount that something differs from a fixed value or standard

5 A I M A O N O C T C M D O

A

room or building in which someone may live or stay

6 T R E D E N

T

process when businesses are invited to bid for contracts to provide goods or services

7 A L C O N I T C R E E A

A

the rate of change of velocity

8 S L W O H L A

S

not very deep

9 P S O N I R U P O L

P

action of driving or pushing forward

10 A T U M J E D T S N

A

a small change made to something to achieve a desired effect

11 P M I A L E R Y R I N

P

preceding or done in preparation for something more important

12 C I L P S A L E B O L

C

able to be folded into a more compact shape

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

FIND WORDS

>>> SUPERCAR SUBMARINE // 28

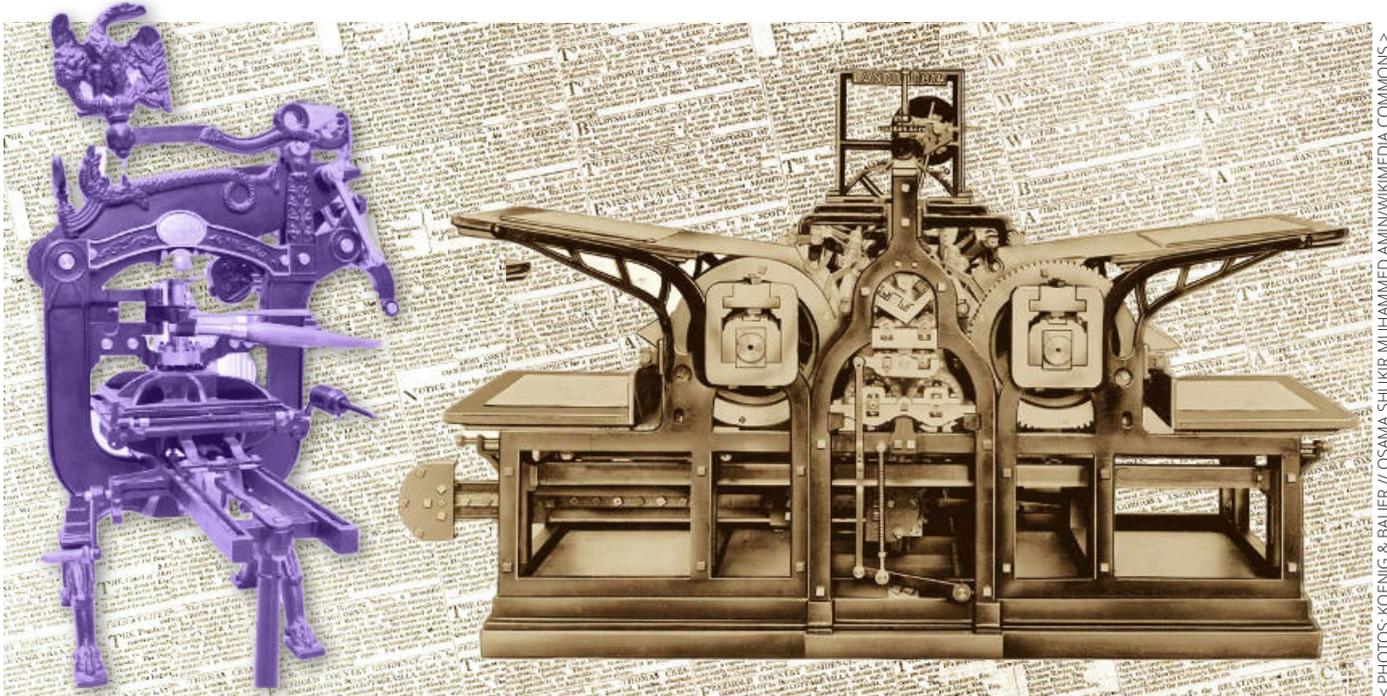
Find words from the article 'Supercar Submarine' which begin with the letters of the word 'Submersible'.

S		having plenty of room
U		not hindered or blocked, especially a view or entrance
B		able to float
M		the act of keeping equipment in good condition
E		travel through an unfamiliar area to learn about it
R		something that is needed or wanted
S		observe and direct the work of someone
I		without outside help; unaided
B		set of instructions given to a person about a job or task
L		free time when you are not working; you can do as you wish
E		excessively high; exorbitant

FAST PRESSES

LISTEN IN

Das Ende der Druckerpresse wird schon seit Jahrzehnten vorausgesagt und nie schien es näher wie im Zeitalter von Tablets und eReadern. Doch noch dreht sie sich – Grund genug für einen Blick auf die Geschichte der Druckerpresse.



< PHOTOS: KOENIG & BAUER // OSAMA SHUKR MUHAMMED AMIN/WIKIMEDIA COMMONS >

*see list
enormous
gigantic

It's a *visceral thrill* to watch a large *press* in action - paper leaving *huge* rolls that weigh over a ton, flying through a *vast* machine that prints, cuts, and folds it, all faster than the eye can follow. Compare that with a Gutenberg-style hand press, where two printers might finish a few hundred *sheets* per day. Printers still used presses like that during the eighteenth-century Industrial Revolution. Only after that did things begin changing.

First, French printers began adding metal parts and clever mechanisms to presses. Then, around 1800, the Earl of Stanhope built an all-metal press. He used *com-*

pieces of paper

combined

pound levers to drive a conventional screw mechanism. It *imposed* very high pressure at the end of the printing *stroke*. Printers who once had to *impress* each half of the paper separately could now, with far less *effort*, print a whole sheet in one pull of their lever.

During the War of 1812, George Clymer of Philadelphia built his famous Columbian Press. It was lighter than Stanhope's, with a pure lever system. Clymer eliminated the screw drive entirely. He also used a dramatic iron American eagle for the counterweight that lifted the *platen* after each *impression*. Historian James Moran tells how, as

cranks
forced
movement
print
work

*see list... imprint

compound	Verbund-
effort	Anstrengung, Mühe
elm	Ulme
hint at, to	andeuten
huge	riesig, enorm
impose, to	aufbürden, auferlegen
impress, to	aufdrücken
impression	Druck, Abdruck
ink, to	einfärben
inventor	Erfinder, Erfinderin
invert, to	umdrehen
kin	Verwandtschaft, Sippe
lever	Hebel
literate	gebildet, belesen

make inroads, to (made, made)	vorankommen
platen	Drucktiegel
plough	Pflug
press	Druckerpresse
propose, to	vorschlagen, anregen
provide, to	bieten, liefern
rotary	Dreh-, drehend
sheer	rein, schier
sheet	Blatt, (Papier-) Bogen
stroke	Hub, Takt, Schlag
supper	Abendessen
type	Type, Schrift
vast	riesig, gewaltig
visceral thrill	tief bewegendes Erlebnis

Columbian presses went international, other countries would replace the eagle with a globe, a lamp, or a lion.

produced

In any case, hand presses now *provided* far greater outputs of printed matter; but, compared with our huge newspaper presses, they seem intolerably slow. They would clearly have to give way to a steady flow of paper through rollers.

suggested

creator... suggested

**see list 2x*

rotating

That was first *hinted at* by an early seventeenth century Italian *inventor*. He *proposed* rolling a heavy wheel over paper lying on *inked type*. But it was 1790 before William Nicholson patented a *rotary* printing system, and then he failed to build a prototype. Not until 1810 did German inventor Friedrich Koenig begin developing a steam-powered machine whose inked roller printed paper as it flowed by. Koenig also figured out how to print on both sides of paper. Think about that for a moment; just imagine the problem of *inverting* the paper and causing a second roller to place an image correctly on its back.

turning around

It took a generation for those complex cylinder machines to *make serious inroads* on the Columbian press and its *kin*. As they did, the printed word began reaching the general public in ways that would transform the world and transform knowledge. Still it took a steam engine to run those machines. And that high technology could be hard to come by. Iron hand presses were still in wide use until we had electric motors, late in the 19th century.

**see list relatives*

And so, good listener, we came into the joy of cheap books. We became a *literate* people. We learned the *sheer* pleasure of reading - under the *elm* tree, behind the *plough* - aloud after *supper* and in the quiet of our room. <<< John H. Lienhard >>>

well read

absolute

**see list*

**see list...evening meal*

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 <https://engines.egr.uh.edu>



Audiodatei unter

www.kuhf.org/programaudio/engines/eng1998_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 ////

SIGNIFICANT	=	≠	
	=	≠	TIGHT
	=		
		≠	
	=	≠	PROBLEMATIC
EXACT	=	≠	

SHINY
 PRECISE
 IMPORTANT
 ROUGH
 SLACK
 WIDE
 PRACTICAL
 ELONGATED
 BROAD
 TOUGH
 LOOSE
 DULL
 INSUBSTANTIAL
 SIMPLE

EXAMPLES

In some cases, deciding whether to use a singular or a plural verb can be slightly tricky. Take a look at the following examples:

Standard examples:

- The blade **is** *blunt*. / The blades **are** blunt.
- The blade and the handle **are** damaged.

The **initial subject** (i.e. before the 'of') *determines* whether it's a **singular or plural verb**:

- The **list** of parts **is** in the folder.
- The **number** of defects **has** risen.
- **Each** of the models **has** a special *feature*.
- **Neither** of the prototypes **was** successful.

What comes after the 'of' determines whether it's a singular or plural verb (all examples have something to do with quantities, portions, percentages or *fractions*):

- All of the parts **are** recycled. – All of the packaging **is** recycled.
- Some of the products **were** damaged. – Some of the outer *casing* **was** damaged.
- None of the nails **were** still useable. – None of the oil **was** still useable.
- The majority of the components **were** *approved*. – The majority of the data **was** approved.
- A third of the employees **were** directly *affected*. – A third of the land **was** directly affected.

Distances, areas, sums of money and periods of time are generally followed by a **singular verb**:

- 2,000 euros **is** the list price.
- 90 m² **is** the *surface* area.
- 42 kilometres **is** the length of a marathon.
- 30 days **is** the standard delivery time.

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

PRACTICE

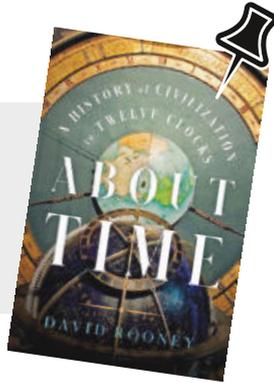
Underline the correct form of the words in bold.

- 1 3.5 million euros **was** // **were** spent on the new training *facilities*.
- 2 The size of the pipes **is** // **are** fixed by the customer.
- 3 Neither of the *proposals* **is** // **are** really suitable.
- 4 The majority of the documents **was** // **were** produced by AI software.
- 5 The number of smart *fulfilment centres* **has** // **have** increased in the last few years.
- 6 Some of the *polls* **shows** // **show** that over 65% of customers **are not** // **is not** satisfied.
- 7 The tests show that none of the products **works** // **work** 100% correctly.
- 8 Three quarters of the surface area **was** // **were** contaminated.
- 9 Each of the flanges **has** // **have** to *undergo* 3 separate stress tests before being certified.
- 10 Most of the papers **was** // **were** written by hand. A large percentage of the paper used in the exam **was** // **were** recycled.
- 11 Nearly all of the trainees **has** // **have** been taken on full time.
- 12 3.5 metres **is** // **are** the longest version we offer.

<i>affect, to</i>	<i>betreffen, beeinträchtigen</i>
<i>approve, to</i>	<i>zulassen, genehmigen</i>
<i>blunt // blɒnt</i>	<i>stumpf</i>
<i>casing</i>	<i>Gehäuse</i>
<i>determine, to // dɪ'tɜ:mɪn</i>	<i>bestimmen</i>
<i>facility</i>	<i>Einrichtung</i>
<i>feature // 'fri:kʃn</i>	<i>Merkmal, Eigenschaft</i>
<i>fraction</i>	<i>Bruch</i>
<i>fulfilment centre</i>	<i>Auftragsabwicklungszentrum</i>
<i>initial // ɪ'nɪʃl</i>	<i>Anfangs-</i>
<i>poll</i>	<i>Umfrage</i>
<i>proposal</i>	<i>Vorschlag</i>
<i>surface // 'sɜ:fɪs</i>	<i>Oberfläche</i>
<i>undergo, to</i>	<i>unterlaufen</i>

PINBOARD

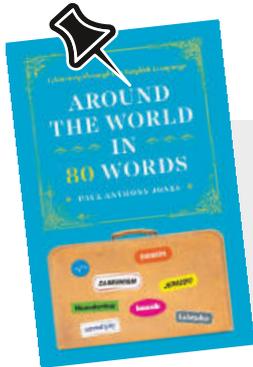
About Time: A History of Civilization in Twelve Clocks
David Rooney
W. W. Norton & Company
ISBN 978-1324021957



ES WIRD ZEIT

Uhren sind weit mehr als reine Zeitmesser: Sie beherrschen unseren Alltag, treiben uns zu Höchstleistungen, synchronisieren Verkehr und Handel und sind ein wichtiges wissenschaftliches Instrument – kurz: Sie formen unsere Zivilisation.

In seinem Buch „About Time“ hat sich David Rooney zwölf dieser Zeitmesser herausgegriffen, die unsere Geschichte und Zivilisation in ganz besonderem Maße beeinflusst haben. Dazu zählen unter anderem römische Sonnenuhren, Al-Jazaris Wasseruhr, ein Observatorium in Indien, Sanduhren, sowie mechanische Uhren bis hin zu Atomuhren. Rooney erzählt, wie diese Uhren neue Formen der Zeitmessung eingeführt haben, wie sie zu politischen und sogar kriegerischen Zwecken genutzt wurden und wie sie umgekehrt dazu beitragen könnten, den Frieden zu sichern. Nicht so sehr eine technische, dafür aber eine umso packendere „Zeitreise“.



Around the World in 80 Words:
A Journey Through the English Language
Paul Anthony Jones
Elliott & Thompson
ISBN 9781783964000

IN 80 WÖRTERN UM DIE WELT

Viele Ortsnamen sind aus ganz normalen Wörtern zusammengesetzt. So bedeutet Casablanca schlicht „das weiße Haus“ oder, nicht ganz so offensichtlich, Chicago „der Platz der wilden Zwiebel“. Paul Anthony Jones dreht diese bekannte Tatsache einfach um und durchforstet das englische Wörterbuch nach Begriffen, die sich von Ortsnamen ableiten. Daraus entstand eine wilde Reise um die Welt auf der Suche nach 80 dieser „Geonyme“, wie er sie nennt.

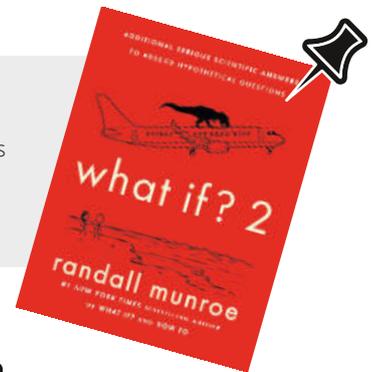
Mitreisende erfahren so, dass der „Panama hat“ gar nicht aus Panama kommt, sondern aus Ecuador und die „French fries“ eben nicht aus Frankreich, sondern aus Belgien. Das ist jedoch erst der Anfang. Auch ein kleiner Kurort an der deutsch-tschechischen Grenze, ein Dorf in Südafrika oder ein jordanischer Berg haben Einzug in die englische Sprache gehalten. Wie bei jedem guten Reiseführer gibt es auch bei Jones' „Around the World in 80 Words“ zu jedem Reiseziel oder Wort eine ausführliche und doch kurzweilige Geschichte.

WAS WÄRE WIRKLICH WENN

Nach dem riesigen Erfolg von Randall Munroes ‚What If‘ war es abzusehen, dass es irgendwann einen zweiten Teil geben wird. Zum einen ist die Art, wie Munroe absurde Fragen ernst nimmt und dann wissenschaftlich begründete Antworten liefert, einfach ein herrlicher Spaß, zum anderen gibt es schlicht einen endlosen Schatz an absurden Fragen.

So widmet sich Munroe im seinem zweiten Band solch weltbewegenden Fragen wie: Könnten wir die Erderwärmung stoppen, indem wir alle den Kühlschrank öffnen? Zu einfach? Wie wär's mit: Was würde passieren, wenn das Sonnensystem bis zum Jupiter mit Suppe gefüllt wäre? Oder etwas praktischer: Was wäre, wenn jemand einen Helikopter startet, während wir uns am Rotoblatt festhalten? Was geschieht, wenn wir neben einem Objekt mit 0 Kelvin stehen? Egal wie schräg die Frage, Munroes Antworten sind stets ebenso unterhaltsam wie lehrreich.

What If? 2: Additional Serious Scientific Answers to Absurd Hypothetical Questions
Randall Munroe
Riverhead Books
ISBN 978-0525537113



VIDEO LINKS

www.youtube.com/@xkcd_whatif

Wem Spaß an Randall Munroes „ernsten“ Antworten auf absurde Fragen hat und wem die beiden „What If“ Bände noch nicht genug sind, findet hier eine Sammlung von kurzen Videos zu so schrägen Dingen wie U-Booten im All, Laser-Regenschirmen oder Plantschen im Abkühlbecken eines Reaktors.

<https://digital.library.cornell.edu/collections/kmodd>
Die Definition von Kinematik – ein Teilbereich der Mechanik, der sich mit der rein geometrischen Bewegung von Körpern befasst – klingt zugegebenermaßen etwas staubig. Das ändert sich jedoch, wenn man sich durch diese Sammlung von über 200 Modellen von Planetengetrieben, Kubel- und Schraubentrieben, Kupplungen und vielen weiteren Mechanismen klickt, die der Gründer der Disziplin, Franz Reuleaux, zusammengetragen hat. Ein wahrer Ideenpool.

https://youtu.be/lszXpzlo_ZQ?feature=shared
Geld: Entweder man hat es oder man hat es nicht. OK, aber wie funktioniert das eigentlich genau mit dem Geldfluss? Diese Frage hat sich die Kartographin Carlijn Kingma gestellt. Die ausführliche Antwort präsentiert Sie in einem wunderschön animierten Video, das den Zahlungsfluss im „Wasserwerk des Geldes“ anschaulich verdeutlicht.

ANSWERS

FEATURE REVIEW >>

MAGLEV

1. less
2. a few
3. less
4. a few
5. a few / fewer
6. less / fewer / less
7. a few / few
8. a few
9. fewer / less
10. few

FEATURE REVIEW >> HISTORY

1. fully // significantly
2. easily // ordinary (no change)
3. environmentally
4. heavily
5. commercial (no change) // simply
6. really // economically // expensive (no change)
7. likely
8. normally
9. basically
10. precisely // architectural (no change) // ultimately

FEATURE REVIEW >>

WIND-ASSISTED SHIPS

1. appearance
2. challenging
3. expertise
4. deviation
5. accommodation
6. tender
7. acceleration
8. shallow
9. propulsion
10. adjustment
11. preliminary
12. collapsible

FEATURE REVIEW >> SUBMERSIBLES

- S spacious
 U unobstructed
 B buoyant
 M maintenance
 E explore
 R requirement
 S supervise
 I independently
 B brief
 L leisure
 E extortionate

WORD COMBINATIONS

A

1. unit price
2. unit cost
3. unit pump
4. unit weight
5. air-conditioning unit
6. heating unit
7. control unit
8. intensive-care unit

B

1. room key
2. room rate
3. room temperature
4. room service
5. boiler room
6. control room
7. stock room
8. locker room

TONGUE & GROOVE

significant	=	important	≠	insubstantial
slack	=	loose	≠	tight
wide	=	broad		practical
elongated		shiny	≠	dull
tough	=	problematic	≠	simple
exact	=	precise	≠	rough

CROSSWORD

- | | | |
|----------------|---------------|---------------|
| 1. proPel | 10. tiEr | 19. coMbine |
| 2. apprOPriate | 11. minusCule | 20. agreEment |
| 3. pollute | 12. iniTial | 21. asseMble |
| 4. deploYable | 13. meRge | 22. herBs |
| 5. subMerge | 14. hOld | 23. dRaft |
| 6. tendEr | 15. tensiLe | 24. frAgile |
| 7. alteRation | 16. pYlon | 25. lauNcher |
| 8. strEtch | 17. shuTtle | 26. guidEway |
| 9. pilLar | 18. vErsus | |

THE MANUAL

HOT GLUE GUN // General Operation

Turn on the glue gun by **plugging** it into a mains powered outlet. Insert a **glue stick** into the gun through the feeder tube and allow the glue gun to heat up for approximately five minutes before use. Squeeze the trigger a few times to further load the stick into the gun until you feel a slight **resistance**. The hot glue gun is now ready for use.

Hold the **nozzle** against the surface to be glued and press the flow control trigger to **deposit** glue. The trigger may require several operations before the glue starts to flow. Between gluing operations the glue gun can be rested on the **support bracket**. Be aware that glue might **drip** after operation and ensure the surface the glue gun is placed upon can handle the heat and is not damaged by the glue.

Caution: If your skin comes into contact with the nozzle or hot glue a serious burn may occur. Hot melt glue should not be used in place of a structural fastener, to hold heavy loads nor in any **application** that will be exposed to heat.

TORQUE WRENCH // Setting the Torque

Unlock the safety locking by pulling the **lock ring** on the handle into the 'unlocked' position. Turn the handle until the top edge of the handle lines up with the nearest value below the **desired** torque on the scale. Be aware that the scale is in ft-lbs on one side of the torque wrench and Nm on the other side. At the end of the handle there is a secondary **fine-tuning** torque scale ranging from 0 to 4 around the **circumference** of the handle. The value of this scale is added to the value shown just above the handle. Make sure the lock ring is in the locked position after you have finished setting the torque value.

Install the required **socket** to the square drive and tighten the **nut** or bolt slowing to a smooth, steady pull as the nut or bolt becomes **snug**. When the wrench clicks, the torque setting has been reached. Do not continue to pull after the torque setting is reached. After every use, set to the lowest torque setting and **lock** the wrench.

DRAWING BOARD

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

FLOW CHAT

I	reservation
K	just a moment
B	extend that by a day
A	that should be fine
J	complete
C	get in and out
F	registration
E	I'm afraid
L	can't miss it
D	when does the dining room open
G	on foot
H	all part of the service

GRAMMAR

- was
- is
- is
- were
- has
- show / are not
- work
- was
- has
- were / was
- have
- is

REVERB

- | | |
|-----------------------|----------|
| 1. has | a. 5 |
| 2. operates | b. 12 |
| 3. was founded | c. 3 / 8 |
| 4. specialized | d. 11 |
| 5. had opened | e. 1 / 2 |
| 6. has been operating | f. 6 / 9 |
| 7. aimed | g. 10 |
| 8. was listed | h. 4 / 7 |
| 9. has been | |
| 10. is leading | |
| 11. will have reduced | |
| 12. will phase out | |

TEAM



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Inch

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INCHBYINCH

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 Lesererleichterung 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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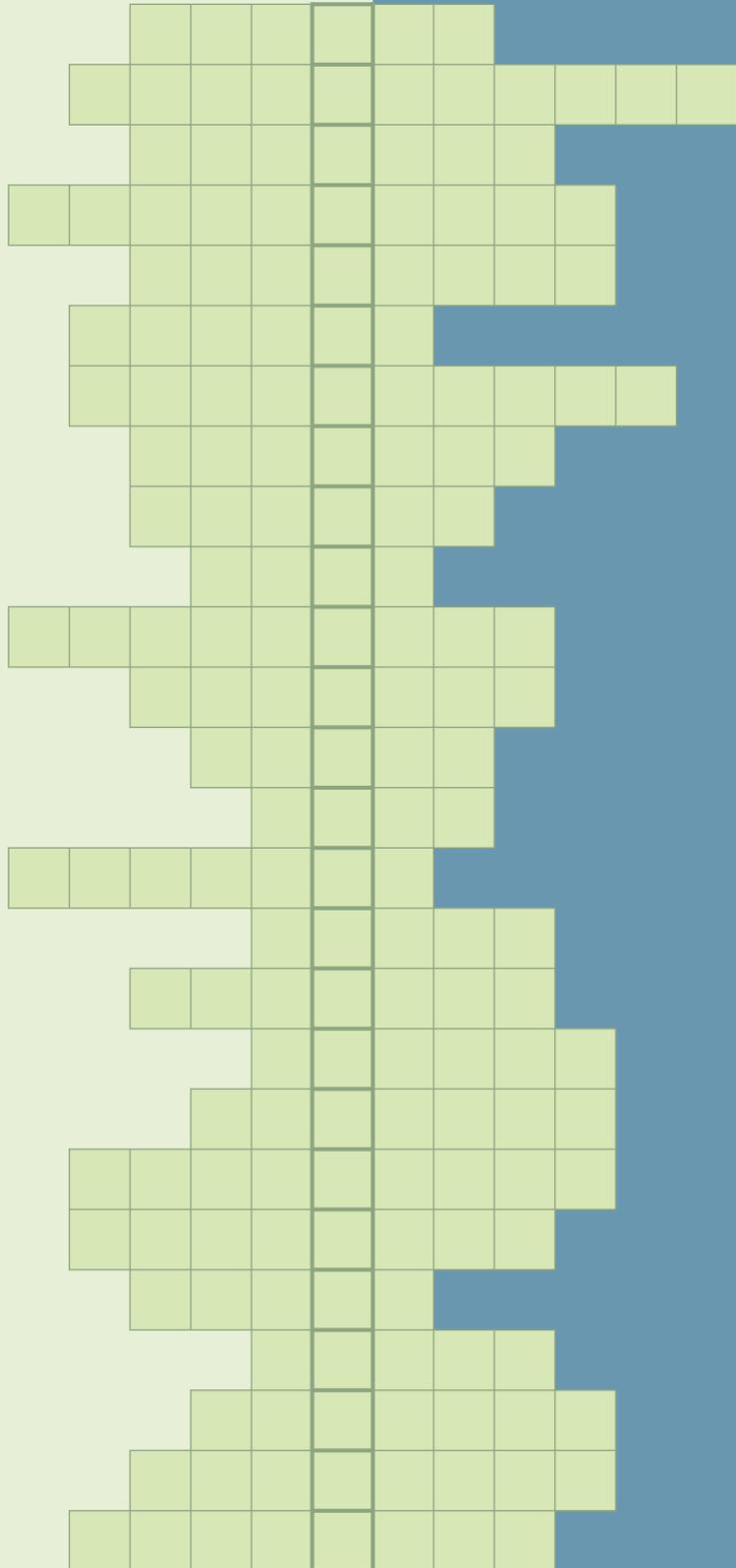
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CROSSWORD

All of the words in the crossword below can be found in the wordlists in this issue of Inch. The highlighted column in the middle will reveal what PEM (a type of fuel cell) stands for.

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

- 1 To drive something forward.
- 2 Suitable, fitting.
- 3 To contaminate something, maybe the environment, with harmful substances.
- 4 If something can be put to use in a certain place, it is this.
- 5 To put something completely under water.
- 6 Another word for a bid.
- 7 A change; a modification.
- 8 To pull something to make it longer.
- 9 A vertical support structure for a building, made of stone or wood, for example.
- 10 Another word for a level, or a layer,
- 11 Tiny; very small; minute.
- 12 First; original; maybe the first letter of your name.
- 13 To bring two things together, maybe make two companies into one.
- 14 The place on a ship or a plane where the cargo is stored.
- 15 _____ strength: how strong something is when is is pulled or drawn out.
- 16 A structure used for carrying electricity cables above the ground.
- 17 To carry or transport something back and forward, maybe to space and back, for example.
- 18 Against, in a sports match, for example; in contrast to.
- 19 _____ harvester: a farm machine for cutting crops and separating the grain from the stem.
- 20 Consensus; a contract.
- 21 To put or fit together, maybe in a factory.
- 22 Oregano, basil, dill, thyme, parsley, for example.
- 23 The first version of a document.
- 24 Easily broken.
- 25 The thing that sends a rocket off into space.
- 26 A rail; a channel; a track; it leads the way for something.



Elektroautos sind sehr erfolgreich und stoßen kein CO₂ aus. Warum also nach alternativen Lösungen suchen? Das war die naive Frage an Jan Van Herle, Experte für Elektrolyse und Brennstoffzellen und Professor an der École Polytechnique Fédérale de Lausanne.

HYDROGEN, FUEL OF THE FUTURE ?

Electric cars have been highly successful, and they don't emit CO₂. So, what's the use of exploring an alternative solution? This was the naive question addressed to Jan Van Herle, an expert in electrolysis and fuel cells, researcher, and professor at the École Polytechnique Fédérale de Lausanne.



< PHOTO: EPFL >

“ Professor Van Herle, aren't electric cars sufficient for clean mobility?

Current electric batteries are not the perfect solution. Their repeated charging and discharging cycles negatively *impact* their *durability*. Besides, recharging takes too long, which is not practical for the users. Their weight *increases* proportionately with the required autonomy and so you quickly reach a limit: it is hardly efficient to fit a battery weighing several hundreds of kilos, part of which will never be used. Moreover, lithium resources are limited and will eventually run out. The use of *hydrogen* would *mitigate* some of these problems.

“ How?

By doing exactly what is already being done in hydrogen cars: Replacing part of the heavy electric battery with a fuel cell and a hydrogen tank that will produce electricity. The cell is the main *source* of energy, the battery *provides* power for *acceleration* and driving dynamics. A combination of the two provides a lighter solution with twice or three times as much autonomy, depending on the case. It also increases the battery's lifespan since the fuel cell keeps it in a *reasonable* charge status – *avoiding* deep discharge. It's a win-win solution.

“ What about the price? A hydrogen car is much more expensive than an electric car.

This is probably the main *obstacle* to their widespread adoption by the public. Some of the materials used in fuel cells are costly. Platinum, used as a catalyser, is expensive, but it is used in smaller and smaller quantities. The polymer of the membrane is not cheap either. Bipolar plates are made of graphite, coated steel, or Titan.

The last of those is expensive. Moreover, it needs to be protected against corrosion in an *acid environment*. However, all these costs depend on production volumes.

Thermal engines, *composed* of thousands of components, are also costly to start with. But since they are mass-produced in 70 million copies a year, the price goes down to 50 euros per kW. If the same tendency *applies to PEM fuel cells*, their price will also drop.

“ There is a strong increase in hydrogen vehicles. However, when we compare their numbers with all car categories, they are *paltry*: 60,000 on the road, 1,000 filling stations planned in Europe by 2030.

Clearly, we are only at the very beginning. *Manufacturers* invest with *prudence*, *evaluate* the *demand*, and move forward step by step. Infrastructure also needs to be developed.

“ Especially since it is not possible to charge one's car “at home” like an electric car.

In theory, it should be possible. Nicolas Hayek, *late* CEO of the Swatch Group and initiator of the Smart micro-car, imagined that houses could have an electrolyser powered by solar panels. It is technically possible, but too expensive and complicated from a safety point of view.

“ Further upstream, there is the problem of the origin of the hydrogen used. Currently, 95% of its production comes from fossil energy, which ruins the very idea of “clean vehicles”.

For mobility, green hydrogen is a must; otherwise, it makes no sense. The proportion you *mention* can be explained by the current dominant use of hydrogen: heavy industry. It is used to produce ammonia, an essential component of *fertilisers*, to produce methanol, to remove *sulphur* from oil and to create *value-added* petroleum products. These are *large-scale* uses, and the hydrogen is *derived* from fossil fuels because they are the cheapest. By extracting it from natural

gas, coal or, in the case of the petrol industry, from petrol itself, it costs 1-2 euros a kilo.

“ So how can green hydrogen be produced?

By electrolysis of water using energy from renewable sources – photovoltaic, wind, hydro.

“ Is this feasible on a large scale?

The world, and Europe in particular, is *engaging huge* resources in energy *transition*, of which solar and wind power are the *pillars*.

Hydrogen is part of this effort because it offers a solution to the problem of *storing* renewable energy.

“ For example?

We can't “store” the *excess* electricity produced by a 2-MW wind turbine in the electricity *grid*, but we can put an electrolyser at the foot of the wind turbine, which will use electricity to produce hydrogen, which can then be stored and used later. We still need to *improve* the various solutions for storing and transporting H₂, which represents a heavy weight in the overall energy balance of this solution. However, scientists and politicians are pushing for large electrolysis capacities. Gigafactories of electrolysers are being *considered* to *capture* green energy and transform it into hydrogen.

“ What is required to boost this development even further? Technological innovation or policy?

Both. A transition of this kind can't happen without strong political will. Technologically speaking, nothing is ever finished: The *combustion engine* has been around for 150 years, and *billions* are still injected every year to improve it. For fuel cells, we need to find ways of reducing the use of platinum. Because it's expensive, limited, *polluting* to *extract* and *fragile* to *source*.

“ In conclusion, what is your vision of the future of hydrogen-powered vehicles? Will they become dominant?

No, they won't. They will coexist with various *complementary* solutions. Electric batteries seem to be the best solution for light vehicles – bicycles, motorbikes, cars, etc. Fuel cells for heavier vehicles – commercial vehicles, *lorries*, boats, trains, etc. For very heavy vehicles and for covering large distances, fuel cells *pose* a storage problem, so liquid fuels will be used because their energy *density* is better. Ammonia and methanol are being considered, and we need hydrogen to produce them. Green mobility will need all these technologies. <<< >>>

Dies ist ein Auszug aus einem Interview, das ursprünglich im Connected Magazine, Ausgabe 20 im Winter 2023, erschienen ist. Die Veröffentlichung erfolgt mit freundlicher Genehmigung von Lemo. Vollständiges Interview unter: www.lemo.com/article/hydrogen-fuel-future

<https://people.epfl.ch/jan.vanherle>

Homepage von Prof. Jan Van Herle an der EPFL.

<i>acceleration</i> // ək,sələ'reɪʃn	Beschleunigung
<i>acid</i> // 'æsɪd	Säure
<i>apply to sth., to</i>	zutreffen auf, gelten für
<i>avoid, to</i>	vermeiden, umgehen
<i>billion</i>	Milliarde
<i>boost, to</i>	fördern, ankurbeln
<i>capture, to</i>	erfassen, aufnehmen
<i>combustion engine</i>	Verbrennungsmotor
<i>complementary</i>	ergänzend
<i>compose, to</i>	zusammensetzen, bilden
<i>conclusion</i>	Schlussfolgerung, Ergebnis
<i>consider, to</i>	betrachten, erachten
<i>demand</i>	Nachfrage, Bedarf
<i>density</i>	Dichte
<i>derive, to</i>	ableiten, erlangen
<i>durability</i>	Haltbarkeit, Langlebigkeit
<i>engage, to</i>	einsetzen, anstellen
<i>environment</i> // ɪn'vaɪrənmənt	Umgebung, Umwelt
<i>evaluate, to</i>	bewerten, abwägen, untersuchen
<i>excess</i>	Überschuss
<i>explore, to</i>	untersuchen, erkunden
<i>extract, to</i>	extrahieren, gewinnen, fördern
<i>feasible</i>	machbar, praktikabel
<i>fertiliser</i> // 'fɜ:təlaɪzə	Düngemittel
<i>fragile</i> // 'frædʒaɪl	zerbrechlich, anfällig
<i>fuel cell</i>	Brennstoffzelle
<i>grid</i>	Netz
<i>huge</i> // hju:dʒ	riesig, enorm
<i>hydrogen</i> // 'haɪdrədʒən	Wasserstoff
<i>impact, to</i>	beeinflussen, Auswirkung haben
<i>improve, to</i>	verbessern, steigern
<i>increase, to</i> // ɪn'kri:s	erhöhen, steigern
<i>large-scale</i>	i. großen Maßstab, groß angelegt
<i>late</i>	hier: verstorben
<i>lorry</i>	Lastkraftwagen
<i>manufacturer</i> // ,mænjʊ'fæktʃərə	Hersteller
<i>mention, to</i>	erwähnen, nennen
<i>mitigate, to</i>	mildern, abschwächen
<i>obstacle</i> // 'ɒbstəkl	Hindernis, Hinderungsgrund
<i>paltry</i> // 'pɔ:ltri	dürftig
<i>PEM fuel cell (Polymer Electrolyte Membrane)</i>	Polymerelektrolytmembran-Brennstoffzelle
<i>pillar</i>	Säule, Pfeiler
<i>policy</i>	Politik
<i>pollute, to</i>	verschmutzen, verunreinigen
<i>pose, to</i>	stellen, aufwerfen
<i>provide, to</i>	bieten, liefern
<i>prudence</i> // 'pru:dns	Umsicht, Besonnenheit
<i>reasonable</i>	vernünftig, akzeptabel, sinnvoll
<i>require, to</i>	erfordern, benötigen
<i>solution</i> // sə'lu:ʃn	Lösung
<i>source</i>	Quelle
<i>source, to</i> // sɔ:s	beziehen
<i>store, to</i>	speichern, lagern
<i>sufficient</i> // sə'fɪʃnt	ausreichend, genügend
<i>sulphur</i> // 'sʌlfə	Schwefel
<i>transition</i>	Übergang, Wechsel
<i>value-added</i>	Mehrwert, Zusatznutzen



TELL ME HOW OLD YOU ARE!



Mr Gylby has been digging a new **junk room** in his **burrow** and has come across a **bone**. Using his detective **expertise**, he came to the **conclusion**: It's from the **Stone Age**! Archaeologists can actually **estimate** the age of an artefact from its position in the ground.



STRATIGRAPHY

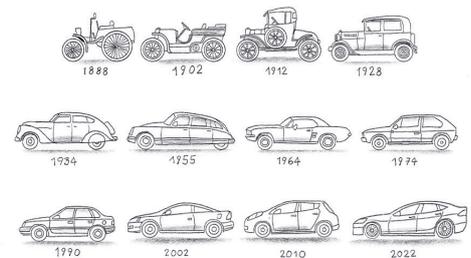
This art is called stratigraphy. The **artefact** itself also **reveals** a lot about its origin. If you know how to categorise it typologically. Stratigraphy is a method that can be used **to determine** age. The deeper something is **buried** in the ground, the older it is. The different layers of rock are just like a cake with a cake base, cream, chocolate, fruit and other **layers**. The cream with the cherry is the last to be put on the cake. The base is the oldest part. So a cup is younger than a **blade** which is found in a deeper area.

TYOLOGY

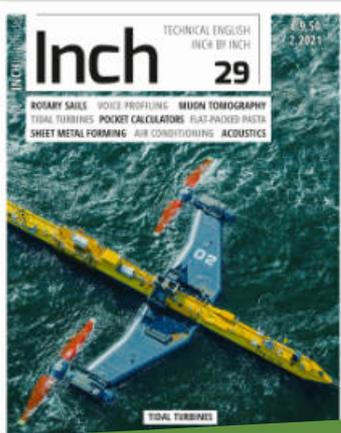
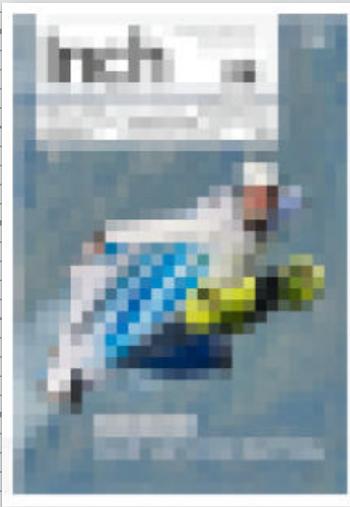
The material of the artefact reveals a lot about its age. Clothing, **jewellery**, **tools** and **implements** can only be made with the materials you have.

In the Stone Age, axes and knives were only made from stone. It was not until the **Bronze Age** that metals could be produced. In addition to that, there have always been '**fashions**'. In the **Neolithic Age**, for example, **shell necklaces** were fashionable. In ancient Greece, pots were painted. With gods and **heroes**. In the beginning, they were simple drawings. Over time, they became more detailed and precise. It's like cars. They change their **appearance** from decade to decade. First they were open, then they became longer, then smaller, more **streamlined** and finally larger again. Fifty years ago, cars were often colourful, today they are mostly silver, grey, black or white.

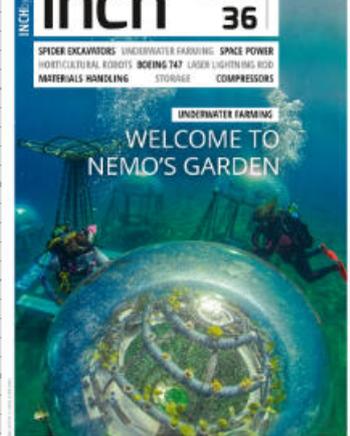
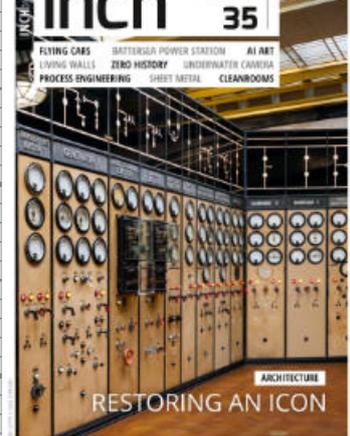
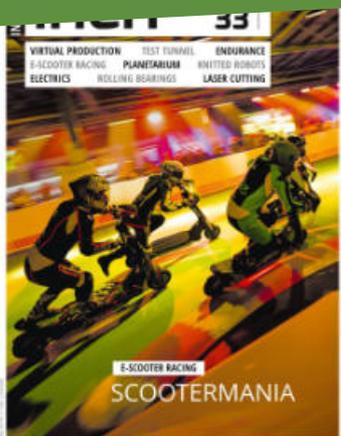
junk room	Rumpelkammer	layer	Schicht
burrow	Maulwurfbau	blade	Klinge
bone	Knochen	jewellery	Schmuck
expertise	Scharfsinn, Fachwissen	tool	Werkzeug
conclusion	Schlußfolgerung	implements	Utensilien
Stone Age	Steinzeit	Bronze Age	Bronzezeit
estimate, to	schätzen	fashion	Mode
artefact	Fundstück	Neolithic Age	Jungsteinzeit
reveal	zeigen	shell necklace	Muschelhalskette
determine, to	bestimmen	hero	Held
bury, to	vergraben	appearance	Aussehen
		streamlined	windschnittig

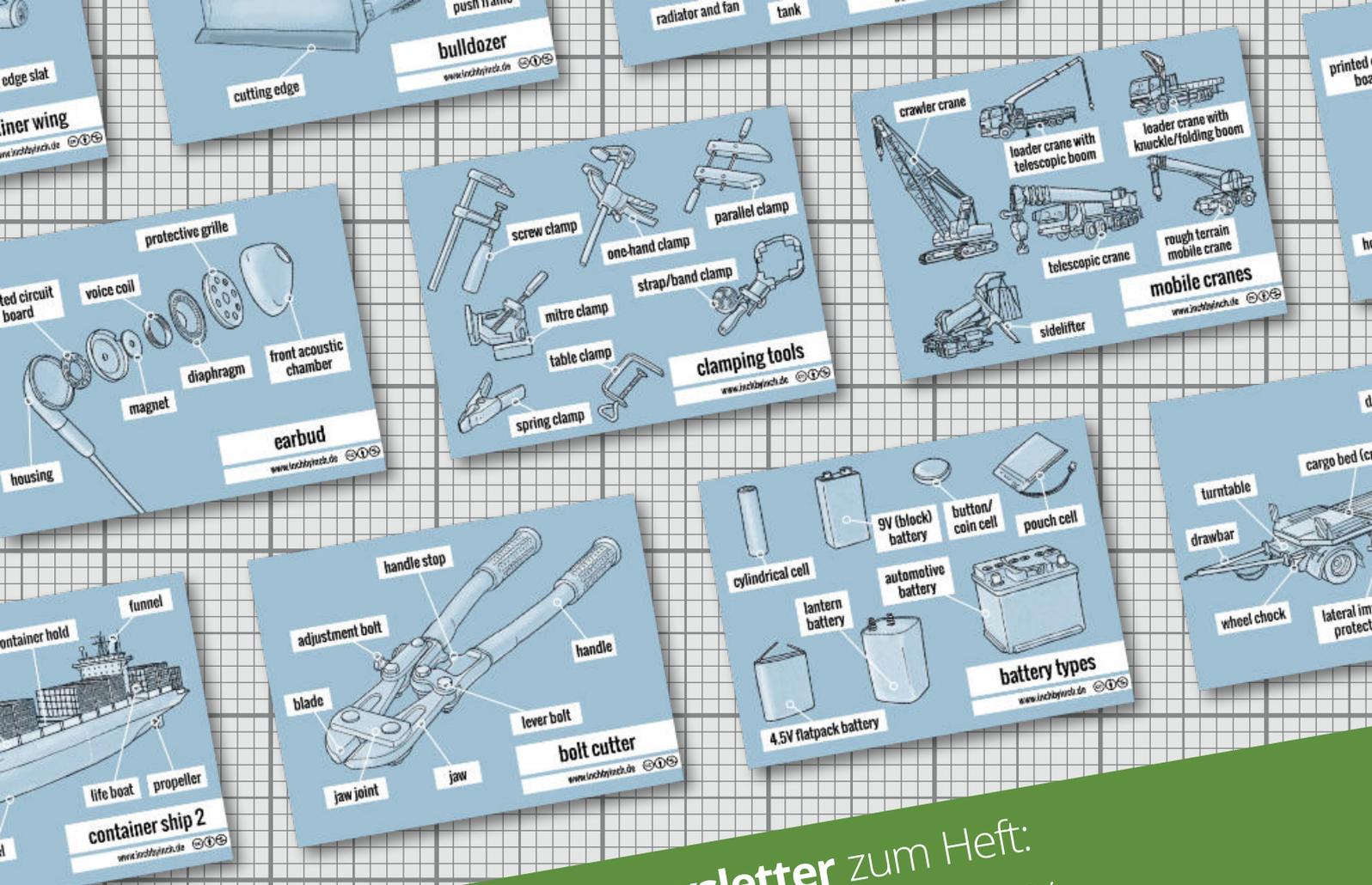


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