TROX

life magazine

no. 21

Air + pharmaceuticals.

Ventilation concepts
in the pharmaceutical industry.

Air and pharmaceuticals: A fascinating subject.

According to the latest edition of Pharma-Daten (Pharma Data), published by the German Pharmaceutical Industry Association (BPI), nearly 600 pharmaceutical companies are registered in Germany. The group is made up of owner-managed companies with ties to particular locations, plus subsidiaries of multinational corporations. A surprising fact is that although German pharmaceutical companies are global players, but over 90% of the pharmaceutical manufacturers in Germany employ fewer than 500 people. In 2018, 223 of these companies had fewer than 20 employees. The pharmaceutical industry therefore mirrors the structure of the German economy. The industry's unique significance to the economy stems not only from direct value-added effects, but also those that are indirect and induced. After all, the pharmaceutical industry plays a significant role in the economic development of a country and in keeping the global population healthy. That's why we have chosen to focus on air and pharmaceuticals in this issue of TROX life.

Fittingly, we feature the Pfizer production facility in Freiburg – a milestone project. HighCon (high containment factory) is considered one of the largest and most modern digital pharmaceutical production facilities in Europe and, thanks to innovative processes and technologies, will be the most efficient site providing above-average productivity. In the highly sensitive areas of HighCon, X-CUBE, the specialist hygiene-optimised central unit, ensures the highest level of safety, reliability and quality.

In the early stages of drug development, around 10,000 molecules are considered as possible active substances on the basis that they may influence a disease-relevant target in the organism. It usually takes about eight to twelve years for just one of these substances to successfully pass the regulatory approval process. Our report on the history of medication ties in with this. Did you know that India gave 'vaccinations' against smallpox more than 3000 years ago? Or that the successful treatment of diphtheria dates back 120 years?

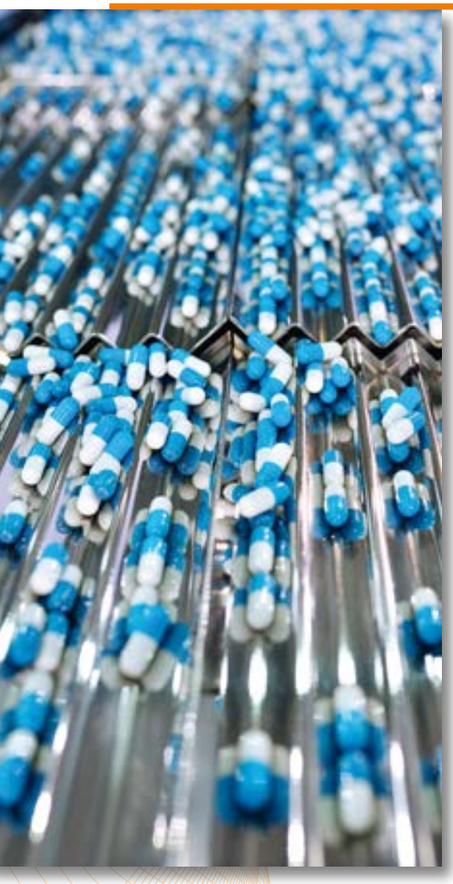
TROX has been a reliable and innovative partner to the pharmaceutical industry for decades now. It was in the 1990s that we first developed LABCONTROL, an innovative control system for highly sensitive areas. We have also been supplying highly efficient particulate filters to ensure the safe operation of pharmaceutical production facilities since the 1980s. Now more than ever, we are in an ideal position to provide our partners with comprehensive advice. All this is underlined in the interview with our Head of Technology, Ralf Joneleit, who discusses the company's strategic approach.

In this issue, we also look at AI, a significant competitive and safety factor both in pharmaceutical production and for air conditioning and ventilation. It's clear that air and pharmaceuticals make for a fascinating subject – so we hope you enjoy reading all about them!

Yours Udo Jung
TROX Board of Management

Sustainable clean room concept at Pfizer in Freiburg.

In 1849, the German emigrants Karl Pfizer and Karl Erhart founded the company Charles Pfizer & Company in New York. Over time, Pfizer developed into one of the world's biggest pharmaceutical manufacturers.



A look into the future production hall.

KSFS type HEPA extract air filters (ducted particulate filters) ensure the highest safety standards in critical process areas.

Freiburg is one of the largest Pfizer solid dosage form production sites in the world. Five billion tablets and capsules are produced there every year. The new production facility will mainly produce drugs for the treatment of cardiovascular diseases and certain cancers.

Once completed, the new factory will be able to produce up to seven billion units. HighCon (high containment factory) is considered one of the largest and most modern production facilities for highly effective drugs in Europe (containment production) and, thanks to innovative processes and technologies, will be the most efficient site providing above-average productivity.

Sustainable production at Pfizer.

The sustainability strategy adopted by Pfizer is based on the UN's Sustainable Development Goals. Pfizer has set itself the aim of manufacturing in an energy-efficient manner, which is why consumption at the Freiburg production facility has fallen in recent years – despite production volume doubling.

Energy-efficient room air concept.

A reliable and safe ventilation and air-conditioning system relies on intelligent air management – combined with effective air filtration (HEPA filter). The integrated concept with components from TROX ensures that the air conditioning and ventilation components function effectively together.

Contamination is avoided in clean room production thanks to the physical principle of targeted positive pressure. The positive pressure prevents air or unwanted particles from entering other areas. Intelligent electronic control systems are responsible for effective control of the positive pressure.

To ensure the safe operation of the clean rooms, several OEB-4-classified high-efficiency particulate air filters of filter class H13 (99.95% @MPPS) were installed in the ceiling. In critical process areas, KSFS type HEPA exhaust filters – ducted particulate filter units made of sheet steel with a decontaminable powder coating and stainless steel clamping mechanism, plus HEPA particulate filters – ensure a constant closing pressure and therefore a tight fit between the casing and the filter element. This is achieved by means of a secure seal and convenient handling using tensioning levers. The filters can be changed easily.

The X-CUBE CROFCU (Clean Room Fan Coil Unit) ventilation system is a particularly economical solution for clean rooms.

In the highly sensitive areas of HighCon, X-CUBE CROFCU, the specialist hygiene-optimised central unit, ensures the highest level of safety, reliability and quality. The effective, high-performance air handling unit achieves a heat recovery efficiency of more than 70%. The supply air and exhaust air heat exchangers are completely separate and are only connected hydraulically to prevent the transfer of odours and substances.

Decentralised solution saves energy.

A special feature is the X-CUBE CROFCU (**Cl**ean **RO**om **F**an **C**oil **U**nit) ventilation system – a particularly economical solution. Clean rooms are characterised by a very high air change rate. At the same time, however, only a few people occupy these spaces, which in turn means that very little air is consumed and only a low outdoor air rate is required as a result. A central supply air system would be associated with a higher volume flow rate, increased energy consumption for conditioning the outside air, higher resistances and a longer distance for the air to travel which would result in higher pressure losses.

X-CUBE CROFCU can be installed in false ceilings.

The more economical system with decentralised units can be fitted in false ceilings owing to the smaller air duct cross-sections. It is supplied with a total air volume of around 100,000 m³/h by three central units. The fact that the outdoor air rate can be reduced cuts energy consumption by around 50%.

HighCon – the factory of the future with a sustainable clean room concept.

In cooperation with Daldrop + Dr.Ing.Huber, a world leader in the design and construction of clean room plants, TROX developed X-CUBE CROFCU, a ventilation unit that sets new standards thanks to its complexity and wide range of applications:

- Space-saving installation due to small duct cross-sections
- Reduced cabling requirements, very short commissioning times on site owing to factory setting of all parameters
- Short routing means minimal pressure losses in the energy-optimised system
- Energy-efficient dissipation of thermal loads
- Integrated control system for a clean room with up to three adjoining rooms
- FAT – Factory Acceptance Test
- HEPA filter for supply and extract air

Ventilation and air conditioning equipment:

- **5 X-CUBE X1** (each providing 32,900 m³/h)
- **1 X-CUBE X2** for high-bay warehouses
- **43 X-CUBE CROFCU** size X
- **17 X-CUBE CROFCU** size XL
- **Various particulate filters** for the supply air
- **Various particulate filters** for the BIBO extract air (Bag-In / Bag-Out) in critical rooms
- **159 KSFS filter units**
- **112 TVR compact controller** (BCO)
- **98 fire dampers FK-EU** and **FKRS-EU**
- **7 smoke control dampers EK2-EU**

Using a calculation tool* which determines the respective energy requirements for thermal conditioning and air transport in hourly increments, Josef Oswald, CEO of Daldrop + Dr.Ing.Huber, instigated a system comparison for the HighCon project.

In the new production areas at Pfizer in Freiburg, a comparison was made between the thermal and electrical energy demands of a clean room system using conventional central air treatment, operating with 100% outdoor air and the demands of a decentralised system based on the X-CUBE CROFCU type of units. The results speak for themselves:

- Lower energy costs – the concept enables a significant saving of approx. 528,000 euros/year, which corresponds to a CO_2 reduction of 1060 t/year.
- By using the decentralised supply air units, the gross external area could be reduced due to the smaller diameter of the duct system in comparison to a system using 100 per cent fresh air. The savings on the duct system amounted to around 1.19 million euros.

* Developed at the Hermann Rietschel Institute, Technical University of Berlin.

X-CUBE CROFCU.

Global requirements for the permitted level of contamination.

In the pharmaceutical industry, high safety standards are essential in production facilities. Therefore, the worldwide OEB requirements (Occupational Exposure Band) specify the maximum permitted contamination levels of products (weight per day). In each case, the levels depend on the toxicity of the substance being processed.

Number of sugar crystals to which an operator may be exposed:

OEB-Level	Maximum user exposure (weight/m³)	Maximum user exposure (weight/day)	Toxic potential	Max. contamination/day in comparison to sugar crystals (sugar crystal ≙ 3 mg)
6	< 200 ng	< 0.01 mg	Extremely high toxic potential	< 0.003
5	< 1 µg	< 0.1 mg	High toxic potential	< 0.03
4	1 – 10 µg	0.1 – 1 mg	Toxic potential	0.03 – 0.3
3	10 – 100 µg	1 – 10 mg	Medium toxic potential	0.3 – 3.3
2	100 – 1000 µg	10 – 100 mg	Low toxic potential	3.3 – 33.3
1	1000 – 5000 µg	> 100 mg	No toxic potential	> 33.3

TROX HGI is responsible for the entire intelligent networking and can continuously monitor the system through remote diagnostics.

Almost all processes are automated on the production lines at Pfizer.

In the new HighCon production section, Pfizer can manufacture products in the OEB 4 category. Thanks to the sealed production facilities with their own separate air supply, employees can work in protective equipment suitable for OEB 3. This means that the plant not only requires less energy, it also improves the working conditions of the employees, who no longer need a mask with filter and can instead work in a basic protective suit and mask.

The operator's verdict.

During the internal tendering process at Pfizer, the concept submitted by Daldrop + Dr.Ing.Huber and TROX was successful due to its cost-effectiveness, quality and efficiency as well as the option for full automation. While Pfizer generated about five billion tablets and capsules per year with the old production system, the new plant will produce seven billion tablets and capsules per year with fewer employees.

Udo Jung,
Managing Director of TROX GmbH,
concludes:

'We are delighted to have such a good partnership with a renowned pharmaceutical manufacturer like Pfizer. Ventilating clean rooms is like playing in the Champions League of air-conditioning and ventilation solutions. To develop and implement sustainable, integrated ventilation concepts that also provide good working conditions and are safe, intelligent and economical, you need excellent cooperation between all parties involved and a focus on the future.'

See the video:
Simply scan the QR code to view the project documentation.

Pharmaceuticals. Driving economic growth.

In 2019, PricewaterhouseCoopers (PwC) conducted an analysis of the European pharmaceutical industry and found it to be a driver of economic growth and an essential component of the economy.

Contribution to the economy.

In 2016, the pharmaceutical sector contributed around 206 billion euros to the gross value added in the European Union. Of this, 13% of turnover went into research and development.

The pharmaceutical sector generated almost 100 billion euros directly. By way of comparison, the automotive industry contributes 211 billion euros directly to gross value added in Europe, and the computer industry, the front-runner, generates 261 billion euros.

The volume of the global pharmaceutical market amounted to around 1.2 trillion US dollars in 2018. Well over half of this was attributable to the five largest national markets: the USA with 485 billion, China with 134 billion, Japan with 85 billion and the two largest European markets, Germany and France, with 52 billion and 34 billion US dollars respectively. According to the Handelsblatt, Bloomberg estimated that the ten largest pharmaceutical companies alone achieved revenues of more than 455 billion dollars. The profit is estimated to be more than one third of the turnover.

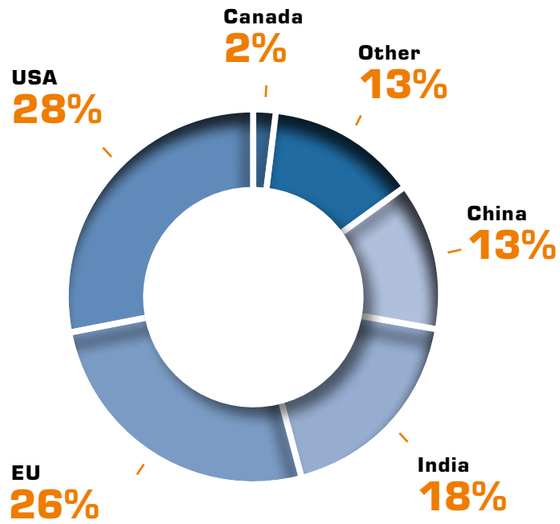
Dependence in the procurement of pharmaceutical products.

Since the start of the COVID-19 pandemic, there have been repeated bottlenecks in supply. First there was a shortage of masks, then there were not enough tests. Now vaccine production is being ramped up to meet demand. Given the limited ability of overseas suppliers to deliver, there have been calls to bring back production of medicines from countries such as China and India. The fact is, however, that in Germany we mainly import active substances and when delivery of these substances is delayed, this partly limits production here locally.

In 2019, Germany exported medical goods worth 106 billion euros, according to the ifo Institute. Imports amounted to 69 billion euros. This means that Germany has a trade surplus in both medicines and medical equipment. Germany sources 72% of its medicine imports from EU member states, and only 0.8% from China and India combined.

The ifo Institute advises to in future stockpile medicines as is the case with strategic oil reserves and to have a wide spread of supplier countries in order to prevent bottlenecks.

Active pharmaceutical ingredients (API):
Share of production sites by country or region, 2019



Source: Yale University

The history of medication.

It is not only in modern times that remedies have been used to fight infections. It is likely that from as early as around 1000 B.C., smallpox was controlled in India by transferring the contents of smallpox pustules from person to person. The first verified documentation of smallpox vaccination dates back to 1549 and was written by the Chinese physician Wan Quan in his work ‘Douzhen xinfa’ (痘疹心法). This vaccination involved grinding up smallpox scabs and blowing the matter into the nostrils of those being inoculated. The resulting immunity decreased the mortality of a smallpox virus infection from 20 to 30% to less than two percent.

Fig. left: Edward Jenner administers the first vaccine against smallpox.

Natural medicine

For thousands of years, herbs or plant extracts were used as a proven means of relieving pain or curing certain diseases. One of the most famous practitioners of early natural medicine was the nun Hildegard von Bingen.

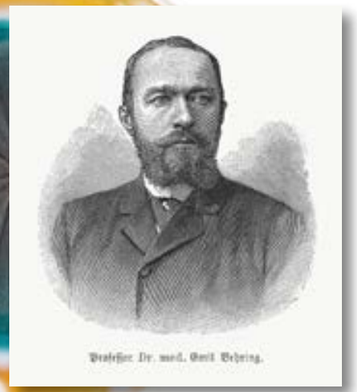
It has only been in the last 130 years or so that pharmaceutical researchers have been able to develop progressively more effective drugs based on individual active substances.

Doctor Edward Jenner, engraving, 1894

Smallpox.
The origins of modern vaccination development.

Similar to the plague and coronavirus, smallpox was transmitted by animals. Large parts of the population, especially children, died from this disease – as late as the 20th century, an estimated 400 million people died worldwide (in comparison: about 97 million died from measles). Nowadays, smallpox is considered to have been eradicated.

In the 18th century, the English rural doctor Edward Jenner observed that farmhands and milkmaids, who had been exposed to the harmless cowpox virus, were immune to smallpox. On May 14, 1796, he vaccinated an 8-year-old boy, James Phipps, with the cowpox or vaccinia virus, which he had taken from a cowpox pustule on the hand of Sarah Nelmes, a milkmaid who had contracted cowpox. Further trials showed that Jenner's vaccination provided reliable protection against this dangerous disease. He pioneered vaccination by pathogens, a method that stimulates the immune system to produce antibodies.


Professor Dr. med. Emil Behring.


Behring's diphtheria remedy: drawing blood from an immunised horse.


Behring's diphtheria remedy: injection.

Behring and diphtheria.

Emil Adolf Behring was a German physician, immunologist and serologist. He was the pioneer of passive antitoxic vaccination (blood serum therapy) and received the first Nobel Prize in Physiology or Medicine in 1901.

Towards the end of the 19th century, many children were dying of diphtheria, an infectious disease of the upper respiratory tract that was also known as the 'strangling angel of children'. While working as a doctor at the Charité hospital in Berlin, Behring witnessed so many children suffering from and succumbing to diphtheria that he was spurred on to research this deadly disease, fight it and ultimately defeat it.

Together with Paul Ehrlich, he successfully developed medication derived from blood serum to treat diphtheria – leading him to be hailed as a saviour of children.

Since the beginning of World War II, the mould (Penicillium notatum) has been cultivated in liquid culture media.

The history of penicillin.

Back in 1874, the surgeon Theodor Billroth in Vienna identified beyond doubt the growth-inhibiting effect the fungus penicillium has on bacteria. Almost 50 years later, Clodomiro Picado Twight, a former scientist at the Institut Pasteur, researched its growth-inhibiting effect on staphylococci and streptococci in San José.

Alexander Fleming studied staphylococci at St Mary's Hospital in London. Before the summer break of 1928, he had inoculated an agar plate with staphylococci and then set it aside. Upon his return on 28 September 1928, he discovered that a mould (Penicillium notatum) was growing on the culture medium and that the bacteria in the vicinity of the fungus had not multiplied. Fleming named the bactericidal substance penicillin.

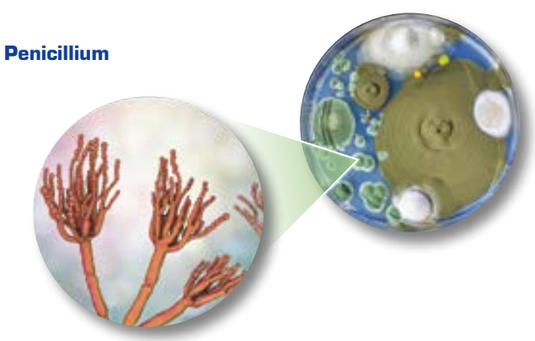
He then examined its effect. He established that penicillin only killed gram-positive bacteria such as staphylococci, streptococci or pneumococci, but not gram-negative bacteria such as salmonella. It was found to be non-toxic to white blood cells and human cells and to rabbits.

In 1939, René Dubos, working at the Rockefeller Institute for Medical Research, isolated tyrothricin from soil samples and demonstrated that it had the ability to cure certain bacterial infections. In 1941, Howard W. Florey and Ernst B. Chain conducted the first clinical trial in Oxford, however, it was limited to a small number of people. Since it was still very arduous to produce penicillin, they even used to recover it from the urine of the people treated with it.

With the outbreak of World War II, the Allies were keen to develop a drug with an antibiotic effect for their wounded soldiers. Researchers in the USA found that it was more beneficial to cultivate the fungus in a suitable liquid culture medium. They cultivated new strains of Penicillium notatum and as a result were able to produce more penicillin. Consequently, the substance became available as a drug in the required quantities. This saved the lives of many soldiers.

In 1945, Fleming, Chain and Florey were jointly awarded the Nobel Prize for their discovery, marking a turning point in the history of medicine.

Penicillium



Milestones in the development of drugs.

The following timeline shows some of the outstanding milestones in pharmaceutical development since the discovery of ever more effective drugs based on single active ingredients.

1885

Vaccination against rabies
(Louis Pasteur)

1891

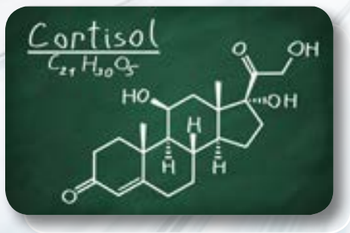
Diphtheria antiserum
against a respiratory infection
that is usually fatal in children
(Emil Behring, Paul Ehrlich)

approx. 1944

Flu vaccine

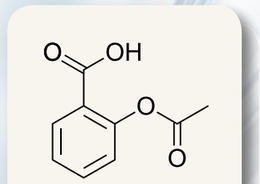
1944

Penicillin available
as a medication



1948

Strong anti-inflammatory:
bioidentical cortisone



Aspirin
Acetylsalicylic acid

$C_9H_8O_4$

1899

Aspirin: pain-relieving,
anti-febrile and
anti-inflammatory
(Felix Hoffmann)

1955

Vaccine
against polio

1922

Animal insulin for the
treatment of diabetes

1956

Sulphonylureas
for the treatment
of type 2 diabetes

1885 to 1956

1958/1959

First diuretics to
lower blood pressure

1960

The contraceptive pill

1960

First immunosuppressive
drug enables organ transplants
to take place

1963

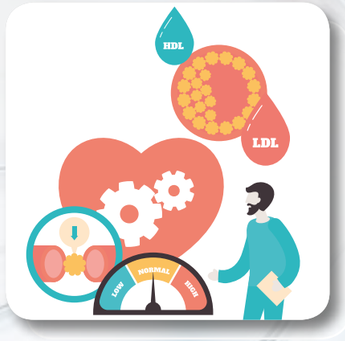
Vaccine
against measles

1980

ACE inhibitors to
lower blood pressure

1980

Eradication of smallpox
through vaccination



1987

Statins to lower
cholesterol and prevent
cardiovascular disease

1987

Medication against
HIV/Aids

1999

New class of drugs
(TNF-alpha inhibitors)
specifically suppresses
inflammation in rheumatism
and Crohn's disease

1958 to 1999

2000

Cure for multidrug-resistant malaria with new drug combination

2006

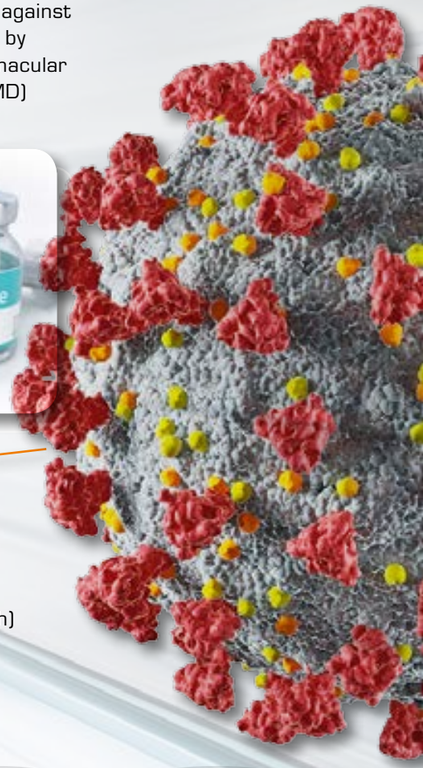
Vaccine against cervical cancer

2007

Drugs with two new modes of action against HIV infections

2007

Antibody therapy against blindness caused by age-related wet macular degeneration (AMD)



2020

First COVID-19 vaccine (BioNTech)

2019

Ebola vaccine

2017

Medication against primary progressive multiple sclerosis

2017

Cancer treatment using genetically modified T cells (CAR T cells)

2017

Vaccine against shingles with a very high protective effect

2000 to 2020

Source: Verband Forschender Arzneimittelhersteller (Association of Research-Based Pharmaceutical Companies).
All data refer to the year in which the medication was first marketed internationally or received approval for the named use.

Drug trials using placebos.

Placebo-controlled clinical trials are used to test a new method of treatment, e.g. a drug or a vaccine. Placebo-controlled trials are usually double-blind randomised controlled trials in which the experimental group receives the drug (independent variable), while the control group receives a placebo. In these studies, not even the doctors know which drug they are administering to whom.

Placebo effect – preparation of drugs for placebo-controlled medical therapy.

The aim is to demonstrate the superiority of a new therapy compared to a placebo or a standard therapy. In clinical research, randomised controlled trials (RCT) serve to answer patient-relevant questions; in drug development, they form the basis for approval decisions by regulatory authorities.

Bacteria communicate.

Two American microbiologists, Prof. Bonnie L. Bassler and Prof. Michael R. Silverman, were awarded the prestigious Paul Ehrlich and Ludwig Darmstaedter Prize** in 2021 for their groundbreaking discoveries in quorum sensing*.

Decoding the language of bacteria.

'Silverman and Bassler have shown that collective behaviour is not only the norm among multicellular organisms, but also among bacteria', explains the Paul Ehrlich Foundation Board. 'Bacteria communicate with each other, listen in on each other, make agreements and in so doing coordinate their behaviour.' The award-winners have effectively deciphered the language of bacteria. 'Communication among bacteria represents an Achilles' heel, first recognised by Silverman and Bassler. Their discoveries in this area have now opened up new approaches to combating microbes. Instead of killing bacteria with antibiotics, substances that inhibit bacterial communication can now be developed.'

* This term refers to the strategy used in bacterial communication.
** The prize is worth €120,000 and is considered one of the most prestigious honours in the field of basic medical research. Many of the scientists awarded the prize in the past decades went on to win the Nobel Prize for Medicine.

Microbiologists awarded the Paul Ehrlich and Ludwig Darmstaedter Prize.

© Bonnie L. Bassler, private

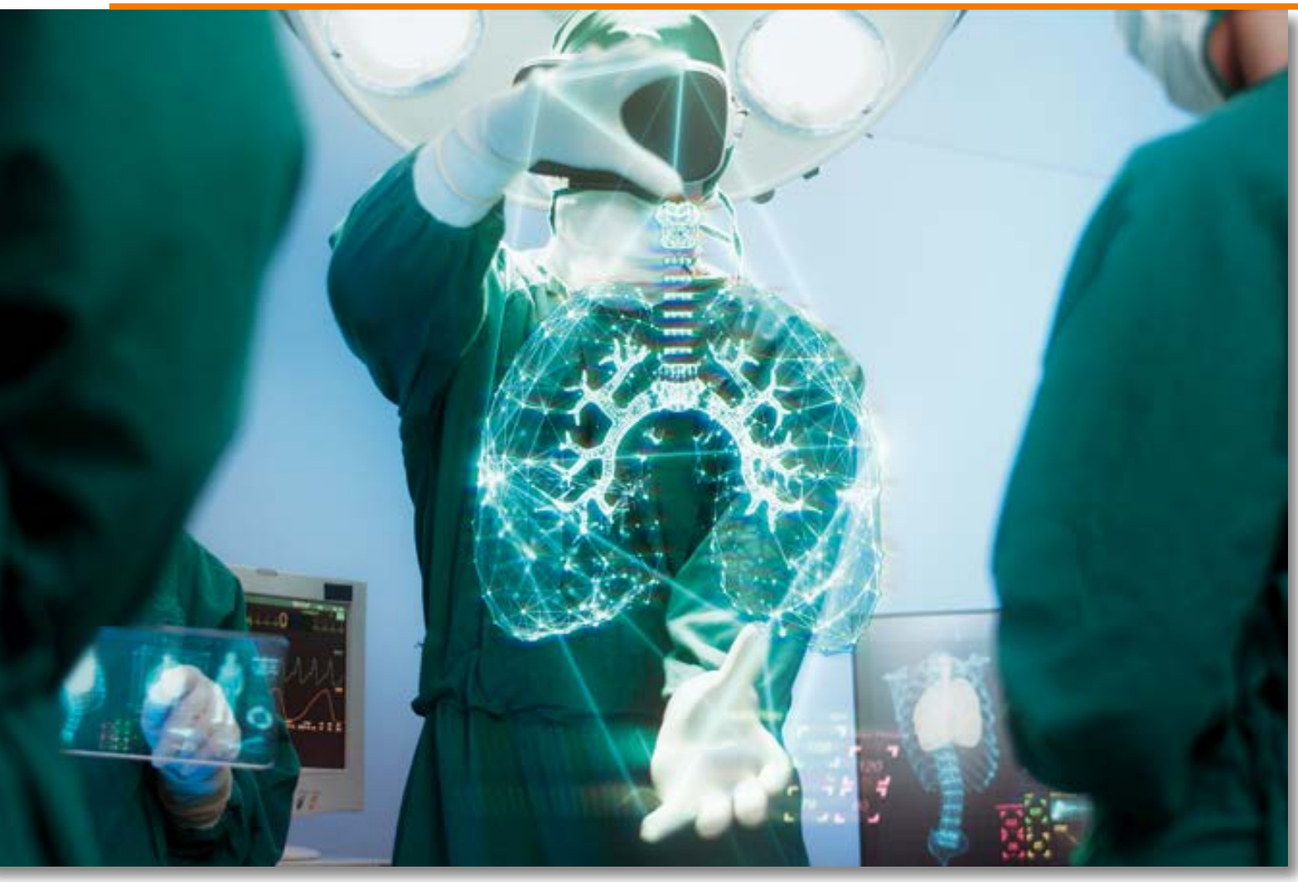
Prof. Bonnie L. Bassler

© Florence McCall, Jackson, Wyoming

Prof. Michael R. Silverman

Digitalisation and networking are key elements for product development, production processes and control in the pharmaceutical industry.

Pharmaceutical industry 4.0



Powerful systems acquire process and product data and analyse them in real time. This is valuable information that can be used for optimisation. However, it also facilitates compliance with regulatory requirements – from Good Manufacturing Practice (GMP) and adherence to prescribed contamination levels to international guidelines on serialisation and forgery protection.

Digitalisation and networking provide a new level of flexibility that equips pharmaceutical companies for the challenges of personalised medicine in the future. 'In just a few years, 3D-printed tablets will become part of everyday life, just as virtual reality applications will become commonplace in hospitals', predicts Bertalan Meskó, medical doctor and expert author, in Boehringer Ingelheim's 2016 corporate report. He talks about sensors in the toilet that will analyse urine, envisages doctors working with data glasses in the operating theatre and expects virtual, i.e. faster, testing of new drugs. An article on the website 'Reinraum online' describes the fully monitored digital clean room production, which is being worked on by various organisations (including the Fraunhofer Institute IPA) and is entitled 'Wohlklingende Zukunftsmusik' ('Melodious Dreams of the Future'). According to the article, all this is soon to become reality.

4.0 concepts improve production efficiency, covering everything from procurement to microbiological testing procedures, drug production and logistics. Processes can now be monitored and controlled more precisely than ever before – increasingly without the intervention of a human being. Sensors monitor the machine processes involved.

Networked, adaptive production.

Prof. Thomas Bergs, member of the board of directors of the Fraunhofer Institute IPT and holder of the Chair for Manufacturing Process Technology at the Machine Tool Laboratory WZL at RWTH Aachen University, is actively involved in networked and adaptive production. His aim is to use data collection, analysis and exchange to predict manufacturing processes and process chains more accurately, to adhere to them more closely and to document them more thoroughly.

Particularly in quality assurance, it is essential to collect all data documenting the development of any condition changes along the process chain. Machine-integrated sensor technology, wirelessly connected to the analysis tools in the cloud via 5G mobile connections, helps to extract valuable information.

Source: Fraunhofer Institute for Production Technology IPT

Limitless technological potential.

Recently, gene sequencing, for example, has provided the opportunity to develop more precise, individualised treatments. Huge amounts of digital data, such as those collected through genetic tests or fitness wristbands, linked with personal customer data, movement and social media profiles, make forecasting possible. Using real-time analysis, flu epidemics and infections can be predicted regionally, allowing the production of vaccines and medicines to be scaled up as needed.

Source: DITTEL Engineering GmbH

4.0 air conditioning and ventilation systems.

Intelligent regulation and control systems ensure consistent production conditions. Using sensors, they monitor and analyse the environment with regard to temperature, humidity and contamination. In this way, they ensure product quality, protect employees and operate highly effectively and efficiently.

4.0

The modular LABCONTROL air management system, which can be tailored exactly to customer requirements, boasts quick and easy plug & play installation.

Storing pharmaceuticals.

The pharmaceutical industry has stringent regulations governing the storage and transportation of medicines. For many medical products and aids, temperature-controlled storage is essential.

Not all medicines can tolerate any temperature. The majority of pharmaceutical products can be stored and transported at room temperature, i.e. at 15 to 25°C, and in rare cases at 30°C. In 2017, only 5% of the medicinal products invoiced to the statutory health insurance system required special temperature conditions. Of these, 19.5 million had to be refrigerated (e.g. insulin, biologicals) and 8.2 million required a cold chain (e.g. vaccines). The Federal Union of German Pharmacists' Associations (ABDA) has published the key points for ensuring proper cold storage of these medicines in its fact sheet entitled 'Kühllagerung von Arzneimitteln' ('Cold storage of medicinal products').

Ventilation requirements.

When storing medicines and intermediate products, reliable ventilation technology is essential. Temperature (usually stratification between 15 and 25°C) and humidity (25%) must be kept constant at differing heights. In this process, the main challenge lies in the considerable warehouse heights and the large surface areas of the external walls. For this reason, medicines are not usually stored along the external walls, but rather other types of equipment are.

People no longer work in modern high-bay warehouses, instead robots do the work. Air recirculation systems are usually therefore sufficient. In the cold months, the supply air is fed in from below and the extract air is removed from above. In summer, the systems work in reverse, as cold supply air flows downwards.

Strict requirements governing control instruments.

Since homogeneous temperature distribution must be ensured, the storage of medicines is regulated by various national and international regulations and guidelines which guarantee that pharmaceutical products are consistently stored according to defined quality standards (Good Manufacturing Practice).

In a GMP-qualified monitoring and surveillance system, temperature and other environmental data are obtained at defined intervals and transmitted to the control room. The software collects the data in real time for analysis and, if necessary, triggers warnings or alarms which are then communicated to the ventilation system. The ventilation control system must automatically recalibrate if any changes occur.

Distance, hygiene, face mask + ventilation.

At present, infection protection against airborne transmission (droplets and aerosols) is based on maintaining social distancing, personal hygiene and wearing a face mask (known in Germany as the **AHA rules**). It is now widely accepted that reducing the number of airborne pathogens through ventilation with outdoor air and/or targeted air purification can also significantly reduce the risk of infection **(AHA+V).** However, the **'+V'** representing ventilation has not yet been sufficiently defined. A status report from the FGK (a German association for building and indoor air quality) proposes a simplified assessment procedure for rooms in buildings, based on European standards, which can be used to document compliance with the '+V' criteria in a practical and straightforward manner.

In the assessment procedure, rules are defined for ventilation/air purification that reduce the risk of infection with COVID-19. The rules described reflect the latest technological developments, are proportionate and well-established. Their purpose is to make the existing ventilation recommendations feasible and user-friendly.

Ventilation is vital.

To reduce the airborne transmission of viruses, ventilation that quickly removes exhaled air is essential. The most reliable way to do this is with a ventilation system.

Air purifiers that meet specific requirements offer a means of reducing the viral load when a room cannot be adequately ventilated. Nevertheless, air exchange is still important as a means of replacing stale air with outside air. Units with HEPA filters can provide a highly effective solution. It is important that these purifiers achieve a good air flow so that they can circulate the air in the entire room without taking too long. Units with a height of about two metres or more are ideal for this. It is still necessary to ventilate when using air purifiers, otherwise the CO_2 that is emitted during breathing accumulates in the room air.

RadioDuct.

Radio-based RadioDuct control system for energy-efficient refurbishment.

The recent extreme weather conditions wreaking havoc in many areas of the globe have meant that the issue of climate change has never been more pressing. One thing is clear – we need to do more.

Often it is small changes that can make a big difference in existing structures. For example, many of the ventilation systems in use today are not being operated in line with current physical and technical standards. Often, companies are reluctant to optimise their systems because of the additional costs associated with coordinating the systems and the additional infrastructure required.

With RadioDuct, a system module for the radio transmission of relevant air distribution technology data, it is now easier to limit the costs of infrastructure adaptations, especially for existing buildings and refurbishments. RadioDuct uses the air duct system to transmit data between the system components by radio signals. It allows data to be exchanged through the ducts in areas where conventional cables cannot be run or where distances are too great. The method* patented by TROX easily crosses concrete walls and long distances, as the ducts pass through them.

Nowadays, a lot of data is used to carry out energy optimisation which was not the case just a few years ago. One such piece of important data concerns the speed control of the fans according to the characteristic curve of the system. If it is usually operated according to the constant pressure method, in which the duct pressure is measured and kept constant based on a setpoint value, then in modern systems the damper blade positions of the volume flow controllers are used. This information provides an overview of the current pressure conditions in the sub ducts and allows the optimum speed for the fans to be determined.

Transmitting all this data by conventional means is very complex. By combining RadioDuct modules with TROX's own X-AIRCONTROL room control system, the data is delivered to the central unit free of charge and without any requirement for extensive wiring. X-CUBE CONTROL processes this information and can adjust the fan speed accordingly. This is sure to result in savings of 20-30% on energy costs for the fans.

Other data such as status messages, room temperatures, air quality of individual areas, etc. can also be shared in this way. RadioDuct offers an alternative where cable connections are not possible or only possible at great expense. It minimises the installation work and offers a lot of potential for future expansions.

* The duct radio technology is patent-protected by TROX under European patent number EP 2 131 113 B1.

RadioDuct – available now.

You can order RadioDuct now. It offers TROX customers the unique opportunity to unlock the vast potential of existing buildings and expand their business areas with this innovative system.

In conversation with Ralf Joneleit.

TROX technology and the pharmaceutical industry.

In this issue, we talk to Ralf Joneleit, Head of Technology at TROX. Needless to say, we were interested in finding out more about the technical areas that TROX focuses on, especially when it comes to applications such as those in the pharmaceutical industry.

TROX® TECHNIK
The art of handling air
for indoor life quality

Ralf Joneleit, you have been Head of Technology at TROX for several years now. I can imagine it's an exciting area to work in.

Definitely – and an extremely varied one at that. Of course, the key strategic goal it involves is developing and launching innovative, demand-driven products, systems and services that get more intelligent all the time. It's also our responsibility to provide reliable technical data, documentation and tools, and to conduct research and development projects with a focus on our markets and on the future. As well as this, we are heavily involved in standardisation and association work. So the work is certainly exciting and varied – but it's also important to add that we couldn't do any of it without our fantastic TROX technical team.

We have known each other for a number of years now. You have been on the TROX life editorial board right from the start. How did you get involved and what does the role entail?

More than 10 years ago, when we started the customer magazine, I was Project Manager for the company's then-new air handling unit division. They were looking for someone who could convey what was in TROX's technical heart and soul in a way that would be accessible and understandable to readers. My marketing colleagues seemed to think that I was the right person for the job, so I embraced the new challenge and still enjoy it today – even though it requires a lot of extra reading, writing and proofreading in addition to my actual job. It's always really interesting to dive a little deeper into new subject areas, some of which are quite far removed from our core area of ventilation technology. That was the case again this time round, in our focus on pharmaceuticals.

Why is the pharmaceutical industry so interesting to the company?

TROX has been focusing on control technology for decades now thanks to its LABCONTROL system, especially when it comes to sensitive areas such as laboratories and clean rooms.

In addition to that, our product strategy is perfectly suited to this type of application. We are making our high-quality components and air handling units more and more intelligent by using control technology and software, and networking them to create smart systems. Now, as a system provider, we are in an ideal position to serve this branch of industry because our integrated solutions, tools and expertise allow us to support customers throughout the entire planning process – from conceptual design, system configuration and detailed component sizing all the way through to intelligent control and connection to the central BMS technology. This provides our partners with maximum reliability and minimises any interface issues they might encounter.

And finally, we can guarantee that our components and systems are extremely reliable and of the highest quality, which of course is paramount in such sensitive applications.

Can you give us an example?

Yes – in fact, you can read all about this in the last issue of TROX life, which featured a project report on the new Haus M hospital building at Klinikum Karlsruhe. Thanks to our holistic approach, we stayed under budget and were able to develop and implement solutions more quickly. Quite simply, we managed to avoid frayed nerves and spared everyone's wallets! And we delivered a smooth-running system.

Which strategic measures did you take?

By integrating TROX HGI into the TROX GROUP, we have taken an important step towards covering the entire scope of building automation. TROX HGI supported our partners in this project not only with the design and implementation of the control system, but also with the testing, commissioning and activation of the system. Moving forward, HGI will also be responsible for maintaining the building automation system. This is also the case with the Pfizer plant, which we report on in this issue.

So, what you're saying is that TROX is currently evolving from a conventional component supplier in the ventilation technology sector to a system provider.

Yes, exactly. We want to take it a step further too, operating as a solution provider in this market in the future. Our sales and marketing colleagues in key client management are currently working on this and we already have a task force in place. Prospective customers can click on 'Solutions' on our website to explore various options before they start planning. There, they can also get quick access to the right contact person.

Filter technology is another really important consideration, particularly in the pharmaceutical, laboratory and clean room sectors.

Exactly. Take, for example, the fact that TROX is now producing a low-outgassing clean room filter for the first time, certified to meet the highest requirements for production safety in clean rooms. All our clean room filters are classified according to the particle counting method pursuant to EN 1822. However, for certain specific applications like the semiconductor industry, it is not enough to just know the number of particles – it's also important to understand their properties. Typically, volatile organic compounds are outgassed from the materials used for the product.

TROX MFPCR series clean room filters are made of low-outgassing materials so that these substances only occur in the smallest concentrations and the filters remain virtually free of them. The Fraunhofer Institute has tested the outgassing behaviour of the TROX filter according to ISO 14644-5 and that means TROX is now the first company to have been awarded an independent certificate for this.

What other opportunities do you think TROX has to become even better established in the pharmaceutical sector?

We already offer many customised ventilation solutions for different areas of application. We assist our customers with everything from design, planning, installation and commissioning to predictive maintenance using AI. Interfaces are reduced as the connection to the central BMS is integrated. In this way, we are able to create safe, efficient and sustainable ventilation and air conditioning systems for all applications in the pharmaceutical sector. TROX room air management systems are optimised to meet the tough system demands that are typical of clean room applications.

X-CUBE CROFCU, an energy-efficient decentralised system, is specifically designed to satisfy many of the requirements of the pharmaceutical industry (see page 8), or central clean room concepts where the air pattern, mode of operation and efficiency depend on the design of the air inlets and outlets as well as how they are grouped and arranged in the space. With our wide range of air terminal devices, we have perfected the art of air distribution. In areas that people occupy, this translates into maximum thermal comfort and features such as high induction and rapid reduction of temperature differences between room and supply air. It also keeps airflow velocities outside these areas as far as possible, and provides precise and reliable control technology.

Whether you need a centralised or decentralised system, TROX can give you a customised solution with a whole host of advantages.

What else does TROX have in the pipeline?

Our new RadioDuct system (see p. 42) can be retrofitted into existing buildings in order to give them demand-based control, resulting in enormous energy savings. And all this without the need for extensive wiring, as it uses radio communication through the ventilation ducts.

And finally, you have been with TROX for over 20 years now – what is it that binds you so strongly to the company?

Right from the start, the company gave me the chance to work independently and also take on responsibility. My work has always been shaped by the partnership I have with my colleagues. It may sound like a cliché, but at TROX we really are like a family. We all pull together in our efforts to create the best possible solutions and a true partnership with our customers. And that makes it easy to go the extra mile for TROX.

The pandemic has really highlighted how important this unity is: it has certainly helped us to get through such a difficult time together and continue to perform well as a company. Admittedly, the pandemic does offer opportunities for the ventilation industry – it's been proven that effective mechanical ventilation significantly reduces the risk of infection. But despite any excitement we might have about this, we'd never lose sight of how serious the situation is, of course.

The impact of the pandemic on the sector is huge, is it not?

Yes, but I think we can twist that statement around – we are very aware of the impact our industry can have in tackling the pandemic. In the beginning, ventilation was perceived as part of the problem, but now it is seen as part of the solution. I only wish that even more attention was paid to the scientific findings on how aerosols are dispersed and how this can be counteracted with appropriate ventilation systems (see also TROX life no. 20, interview with Prof. Kriegel).

The state has provided millions of euros in subsidies aimed at improving areas such as ventilation technology in educational and public institutions. In principle, the government's efforts to promote ventilation system upgrades in public buildings are going in the right direction and we are seeing improvements in this area all the time. However, there are still some major bureaucratic hurdles to overcome and applying for funding is often very complicated, which means that only a small proportion of the money ends up being paid out.

For example, air purifiers that filter up to 99.95% of viruses from indoor air could offer an effective short-term solution to provide better protection against infection in rooms that are not mechanically or adequately ventilated. Over the long term, however, the goal has to be installing mechanical ventilation in the majority of applications, such as schools, as a way of ensuring high indoor air quality with excellent thermal comfort and energy efficiency.

How would you sum up the situation?

There is no denying that these are really exciting times for the industry at the moment. As ventilation experts, we can play a significant role in controlling the pandemic. This calls for reliability and integrity, two of TROX's core values.

But it also means accepting that we are no longer on the sidelines – instead, we've moved to the centre of public interest. Now, it's much more about educating the general public on the uses of ventilation in a clear and comprehensible manner. Our industry must take advantage of this. With future-proof, sustainable solutions and persuasive public relations activities.

For me personally, the task here at TROX presents an exciting and incredibly varied challenge, which I am only too happy to embrace.

FUNCTIONS

- **Head** of TROX Technology
- **Member of the extended Board of Management** of TROX GROUP and TROX GmbH
- **Member of the German Association of Engineers** (VDI)
- **Chairman of the Building Services Advisory Board** of the German Association of Engineers (VDI-FB TGA)
- **Member of the Advisory Board/Board** of the VDI Society for Construction and Building Technology (VDI-GBG)

Ralf Joneleit

The questionnaire was created by Marcel Proust and popularised by the Frankfurter Allgemeine Zeitung (FAZ). We use it to ask quick questions on people's likes and dislikes.

GETTING PERSONAL

Where would you most like to live?	By the sea, be it the Baltic coast in Mecklenburg West Pomerania or the east coast of Australia.
What does real happiness mean to you?	Together with my family, being at one with the underwater world 10…20 metres below the surface of the sea.
What kind of mistakes are you most likely to forgive?	Mistakes we can learn from.
Your favourite fictional heroes?	Inspector Kluftinger and Miss Smilla.
Your favourite historical figure?	Michail Gorbatschow.
Your favourite composer, musician or band?	Depeche Mode.
What's your favourite pastime?	Scuba diving
What's your favourite food?	Any kind of schnitzel.
Which qualities do you most value in friends?	Openness and honesty.
What's your biggest weakness?	At times, I'd like to be a little more patient and laid back.
What would be the worst thing that could happen to you?	If anything happened to my family.
What's your favourite colour?	Turquoise blue.
And your favourite flower?	The cornflower.
Your favourite animal?	Manta ray.
Your favourite book?	The Century Trilogy by Ken Follett, especially 'Edge of Eternity'.
What motto do you live by?	You cannot change the wind, but you can set the sails differently.

Modern life is creating an ever-growing number of unusual anxiety disorders. These include phobias, defined as persistent and excessive fears of an object or situation.

You need more than medication.

Hippopotomonstrosesquippedaliophobie

Digital mobility has led to a type of fear that many of us might consider utterly absurd: nomophobia – the fear of not having or being unable to use your mobile phone. Unusually for this kind of term, the main part of it is not derived from Greek or Latin, but from 'no mobile phone', with 'phobia' then tacked onto the end.

Most people have heard of claustrophobia – the fear of confined spaces. It is often assumed that agoraphobia is simply the opposite – the fear of open spaces. However, it is a little more complicated than that, as it is also a fear of being in situations where escape may be difficult or help unavailable.

Have you ever heard of hippopotomonstrosesquippedaliophobia? Interestingly, this strange phobia was originally called sesquipedalophobia, from the Latin words 'sesqui', meaning 'one and a half', and 'pedis', meaning 'foot'. In Roman poetry, it was used to describe words that were a foot and a half long.

Some joker thought that this term was too short to describe the fear of long words and created the new term hippopotomonstrosesquippedaliophobia – which in itself can literally fill you with fear.

Want to hear another word monstrosity? How about hexakosioihexekontahexaphobia, the fear of the number 666. It is made up of a few ancient Greek words: hexakosioi (six hundred) + hexekonta (sixty) + hex (six) + phobia. This term has its origin in the Book of Revelation, in which the end of the world is prophesied – and, of course, the number 666 is primarily associated with the devil himself.

Staying with numbers, many people think the number 13 is unlucky, and some even suffer from triskaidekaphobia, the fear of the number 13. However, this is topped by paraskavedekatriaphobia, the fear of Friday the 13th.

The list of unusual phobias is never-ending. And when you read the next example, even the chickens will be laughing*, as the German saying goes. With a population of close to 23 billion, chickens are the most prevalent bird species. Those who suffer from alektorophobia experience panic attacks and break out in a sweat at the sight of chickens (so a trip to KFC probably isn't a good idea).

How about this for an unusual phobia: arachibutyrophobia, not to be confused with arachnophobia, the fear of eight-legged creepy-crawlies. Arachibutyrophobia is the fear of peanut butter sticking to the roof of your mouth (arachis is Latin for the peanut plant, and butyrum for butter). If that's the case, I think we need to invent a new word: caramelaphobia. Or is it just me who worries that the caramel will get stuck to the roof of my mouth, or even worse – dislodge a filling?

To be quite honest, some of these examples seem quite bizarre. But do they represent an opportunity for the pharmaceutical industry? How about developing a non-sticky caramel in capsule form to conquer arachibutyrophobia? Or even a pill that can help you conquer a fear of pills?! They might be just a placebo – but we all know how effective those can be.

* This German saying is based on the assumption that chickens are not the smartest of animals. Going back to our earlier idiom, if even the chickens recognise and laugh (cluck) at something, it must be very silly indeed.

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The art of handling air

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