Walter Lachenmeier

Subjects: Transportation Science & Technology
Contributor: Dirk W. Lachenmeier
Keywords: funding administration ; technology transfer ; vehicle development ; engineering sciences ; process engineering ; lithium-ion battery

Basic Information

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(Sep 1945–Feb 2022）

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1. Brief Introduction

Walter Lachenmeier (ORCID 0000-0002-6097-729X) was born in the city of Lüneburg, Germany, on 8 September 1945. He studied mechanical engineering and general process engineering from 1965 to 1971 at the University of Karlsruhe (the predecessor of the current Karlsruhe Institute of Technology, an elite public research university in Germany) and graduated in 1971 with a diploma degree in chemical engineering. At the same university, he received his doctorate (Dr.-Ing., Doctor of Engineering, equal to Ph.D. degree) in 1976 with a thesis in the field of supersonic combustion, under the supervision of Prof. K. Bier [1]. In 1977, he joined the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) in Bonn-Bad Godesberg, Germany, which is the central, independent research funding organization in Germany. He first worked as a subject specialist for mechanical engineering and later as program director, responsible for supervising a number of engineering science subject areas. Since 1 January 2001, he had been head of the Engineering Sciences Group and was elected as a member of the DFG directorate. At his early retirement on 1 April 2007, he had worked for 30 years at the DFG. Following that, he worked from 2008 to 2009 as a consultant in battery cell technology for automotive and industrial applications and later in battery development at Li-Tec Battery GmbH, Kamenz, Germany. From 2009 to 2010, he was CTO at E-Wolf GmbH, Neuenrade, being responsible for constructing an electrically powered racing car and also for the conversion of a light truck (Multicar) and small cars to electric drive. Finally, from 2014 to 2015, he was CEO at EEBC European Electrical Bus Company GmbH, Frankfurt am Main, Germany, involved in the development, production and distribution of electric mobility concepts, in particular for local public transport and of corresponding electric vehicle fleets for cities and municipalities to achieve emission-free and low-noise cities. He also developed several electric vehicle simulation software tools for EEBC.

Additionally, he was active in an advisory capacity for several universities and on an honorary basis for the Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, Berlin, Germany) and the Research Association for Combustion Engines (Forschungsvereinigung Verbrennungskraftmaschinen e. V., Frankfurt am Main, Germany).

On 20 February 2022, after a serious illness, Walter Lachenmeier passed away at the age of 76. He leaves behind his spouse Helmi, his son Dirk Walter with Angela and his daughter Katrin with Joachim and his grandchildren Dominik and Julia.

Walter was a remarkable scholar with an extreme range of academic interests, from physical chemistry and engineering to life sciences and public health. Through his cooperative, interdisciplinary and collaborative style of work, he could gather and link experts from various disciplines and could also transfer his enthusiasm to young colleagues, leading them to impressive developments, as specifically observed in this later work for the various companies. In that rather short time period between 2008 and 2014, he was able to publish 19 patents in the field of battery technology and electric vehicles. Since his retirement, my father has also published about 20 letters to the editor on various topics, from university politics and alternative energies to microplastic contamination. This serves to indicate his enormous industry and the range of his academic and societal interests.

2. Deutsche Forschungsgemeinschaft (DFG, German Research Foundation)

Prof. André D. Thess, University of Stuttgart, remarked in an obituary note that Walter Lachenmeier was “the epitome of the reliable, humorous, cost-conscious research promoter” [2], and I believe that this remark well characterizes my father’s work at DFG. The major motivation for Walter Lachenmeier was clearly to maintain and improve the high level of research excellency in engineering at German universities. He believed that Germany will only be able to maintain its position as one of the leading export nations by increasing the share of products with the highest value added in the range of export products. He identified the level of education of graduates and young scientists released from universities into industry to be a top priority to achieve this goal and as a joint task of industry and universities. For this reason, Walter Lachenmeier was particularly committed to establishing interdisciplinary joint projects (e.g., between engineering and chemistry [3]) and cooperation between working groups from universities and industry (**Table 1**). Unfortunately, the project participation of industrial companies was still a “taboo subject” for the DFG until the 1990s. In connection with the then emerging public discussion on “research in the ivory tower”, a cautious rethinking initially occurred at the DFG, so that he could get a number of smaller “transfer projects” off the ground. The priority program “Transition”, which goes back to Walter Lachenmeier’s initiative, was established as the first larger project in 1995 with the conceptual participation of the Airbus company [4]. The “Project House Nanomaterials”, established in 1999, was particularly successful and accordingly often cited [5]. It was based on a pioneering new form of partnership between DFG, industry (Degussa, Essen, Germany) and researchers from 6 German universities aiming to develop new technologies for the production of nanomaterials [6]. The DFG has purchased 1000 days of usage time on the Hanau premises of Degussa for just under 6 million euros and finally received 30% additional time for free. Both sides were proud of having launched and successfully completed such a pilot project, which was explicitly not aimed at only one-sided transfer of results [6]. The advantage of the universities was that they could test the results of their basic research at Degussa pilot plants on a larger scale [7]. The novel ceramic Degussa-Separion separators [8], which can be applied to improve the safety of lithium-ion batteries, emerged from “Project House Nanomaterials”. Furthermore, the particle production method was patented with Walter Lachenmeier as co-inventor. The invention includes an elegant method for producing particles using a nozzle-type reactor. Initially, the gas stream is provided, which is accelerated from subsonic to supersonic values of velocity using a downstream method of flow direction. At the end of the second stage of down streaming, a precursor is added to the gas stream. When the precursor is added, the gas stream is affected, which slows down the gas flow, increasing the temperature. This rise in temperature results in the gas-phase reaction of the precursor. The reaction that produces particles is terminated after the temperature of the gas-phase reaction drops [9].

Table 1. Selected major projects funded by the Deutsche Forschungsgemeinschaft (German Research Foundation, DFG), for which Walter Lachenmeier was DFG program contact. Data according to the GEPRIS funding database https://gepris.dfg.de (accessed on 10 April 2022); the database encompasses projects decided upon and approved following 1.1.1999).

Project	Term	Applicant Institution
GRK 91: Modeling and numerical descriptions of technical fluid flows	**1995–2004**	**Technische Universität Darmstadt**
GRK 140: Flow instability and turbulence	**1995–2004**	**Georg-August-Universität Göttingen**
SFB 253: Fundamentals of space plane design	**1989–2003**	**Rheinisch-Westfälische Technische Hochschule Aachen**

Project	Term	Applicant Institution
SFB 255: Transatmospheric flight systems-fundamentals of aerothermodynamics, powerplants and flight mechanics	**1989–2003**	**Technische Universität München**
SFB 259: High-temperature problems of reusable space vehicles	**1990–2003**	**Universität Stuttgart**
SFB 285: Particle interactions in mechanical process engineering	**1995–2004**	**Technische Universität Bergakademie Freiberg**
SFB 365: Environmentally friendly drive technologies for vehicles	**1993–2002**	**Technische Universität München**
SFB 412: Computer-aided modeling and simulation for analysis, synthesis and operation in process engineering	**1996–2004**	**Universität Stuttgart**
SFB 420: Flight metrology-modeling of dynamic systems	**1997–2000**	**Technische Universität Braunschweig**
TFB 38: Optimized drive line	**2003–2006**	**Technische Universität München**
TFB 42: A prediction method for turbulent combustion	**2004–2005**	**Technische Universität München**

Abbreviations: SFB, Collaborative Research Centers; TFB, Transfer Units; GRK, Research Training Groups.

The initiatives mentioned had a pronounced interdisciplinarity in common, which has also been particularly attractive for the active participation of industrial companies because the staffing of correspondingly broad research groups also exceeds the possibilities of large companies. In the sense of bundling resources, active project participation is not only possible and desirable for industrial companies, but also for public institutions, as is shown by the example of the priority program “Multiple scales in fluid mechanics and meteorology”, in which Germany’s National Meteorological Service, Deutscher Wetterdienst (DWD), was participating [10].

Another highlight of my father’s work at DFG was the development of a French–German program on various topics of numerical analysis in a joint effort with the Direction des Sciences de l’Ingénieur Department of the French National Center for Scientific Research (Centre national de la recherche scientifique, CNRS) in the early 1990s [11]. In recognition of his outstanding administrative management of the program, the Direction Scientifique of the Engineering Sciences Department of CNRS awarded Walter Lachenmeier the prestigious CNRS-Medal during the 9th Joint CNRS-DFG Workshop on Numerical Flow Simulation, 26 October 2002 at the Université de Nice-Sophia Antipolis [12].

Thirty years at DFG is a long time, but I can say that my father always found his work exciting because he could experience research up close at his position. He has always endeavored to stay as close as possible to the areas of expertise he supervised. My father used the following words to describe what was really appealing about being a DFG subject officer: “You deal with many scientists who are enthusiastic about their work, and I got infected by that enthusiasm”.

On Friday, 23 November 2007, the Vienna University of Technology organized a farewell colloquium in honor of Walter Lachenmeier. Matthias Kleiner, DFG president at that time, emphasized: “He accompanied process engineering out of the shadows of mechanical engineering toward independence. Here, as in other fields, Lachenmeier had acted like a pioneer for the engineering disciplines in Germany” [13].

3. Batteries for Electric Vehicles

After his retirement, my advice to my father was not only to take care of the house and yard but also to keep himself mentally fit with further projects. Two of the most timely and interesting topics at that time were lithium-ion battery development and the dawn of the electrical car industry. Lithium-ion batteries for vehicles had already been a favorite topic of my father for a long time. In 2007, he prognostically said that “we will drive electric cars in 10 years at the latest”. He also remarked that “money that goes into battery development is money well spent, because the battery is the key component of the electric car” [14].

When he joined Li-Tec Battery GmbH, the development of cell and battery technology for use in electric vehicles became a major topic of Walter Lachenmeier’s creative work in the engineering field (**Table 2**).

Table 2. Summary of patent claims of Walter Lachenmeier.

Major Objectives	Summary of the Claims	Title of Patent	Patent No. [a]
Improve and enhance the performance and lifetime of batteries	Profile strip as protective sheath in battery cells	Profile strip for an electrochemical energy storage device	US 2012/0231310 A1 [15]
	Cooling or magnetic liquid as a means to transport the generated heat	Cooling device and method for cooling an electrochemical energy store	DE 10 2011 100 602 A1 [16]
	Heat-exchanging tubes with cooling liquids or gases along the surface of the battery	Battery cooling system	US 2012/0164507 A1 [17]
	Cooling the system by heat extraction and re-evaporation using refrigerant and absorber	Temperature-controlled battery system	US 2012/0189893 A1 [18]
	Peltier module to generate a temperature difference due to a change in circuit current	Temperature-controlled battery system II	US 2012/0129020 A1 [19]
	Placing a Galvanic cell, cell jacket, heat conducting unit, cell holder, temperature detector and a control unit with the cell.	Accumulator with extended durability	US 2012/0164492 A1 [20]
	Glass fiber nets as a temperature sensor are arranged in parallel across the surface of the separator in cell	Electrical unit working in accordance with Galvanic principles	US 8434940 B2 [21]
	Adding of sensors and control units during the production process to control the performance of the electrochemical cells	Method for increasing the charging capacity of an electrochemical cell comprising a sensor, electrochemical cell comprising a sensor and a production method therefor	WO 2012/156091 A1 [22]
Arrangement, connection and configuration of cells and batteries	Interconnecting the terminals of the adjacent batteries to create stack	Battery arrangement and method for the production thereof	US 2013/0052506 A1 [23]
	Battery receiving device, which is lockable and clamped to maintain the position of the battery	Battery receiving device	US 2012/0164496 A1 [24]
	Battery modules are arranged in a cuboid shape, which saves space and is easy to arrange	Battery module	US 2012/0171552 A1 [25]
	Placing the current conductor in mirror symmetry to create a stack	Electric power cell and electric energy unit	US 2012/0301775 A1 [26]
	Arresters and spacers to improve the battery output	Stacked electric power unit	DE 10 2010 006 390 A1 [27]
	A fixed battery connector reduces chemical loss during the battery working	Contacting element	US 2012/0156544 A1 [28]
	Sealed designed battery to avoid leakage, electrical charge drainage and lower battery efficiency	Method for producing an electrochemical energy storage device and electrochemical energy storage device	DE 10 2010 023 940 A8 [29]

Major Objectives	Summary of the Claims	Title of Patent	Patent No. [a]
Efficiency increases in the supply and storage of energy	Strategy to store energy by converting kinetic energy into mechanical energy	Assembly and method for supplying energy to motorized vehicles	US 2012/0153874 A1 [30]
	Enhancement by using a control unit, mechanical power and a shock absorber	Method and charging apparatus for charging a motor vehicle battery	US 2012/0133334 A1 [31]
	Non-pressurized and pressurized heat exchanger using ball circulation	Ball circulating heat accumulator for storing heat from renewable energy sources has balls that are used in heat exchanger, such that geometrically defined guidance of balls to closed pipes or open channels system is performed	DE 10 2012 019 791 A1 [32]
Production of particles using nozzle type reactor	High-pressure gas stream to produce particles from precursors	Method and device for producing particles	DE 10 2006 055 703 A1 [9]

[a] Most patents were registered in various jurisdictions worldwide. For clarity reasons, the US patent is preferred for citation. If not available, German (DE) patent citations are used.

Generally, Walter Lachenmeier hoped to increase the charging capacity of lithium-ion batteries. By the development of new cathode materials, he expected to have a charging capacity that would well exceed 1 kWh/kg. If it is possible to achieve up to 2 kWh/kg, the range of passenger cars powered only by an electric motor would be equivalent to that of gasoline-powered cars.

The electrochemical cell construction and operation conditions were improved to enhance the performance and lifetime of the battery:

Profile strips may be used to increase the performance and lifetime of the electrochemical cell used in lithium-ion batteries and other conventional batteries. By providing a shielding to the electrochemical cell using a profile strip as a protective layer, the safety of the cell and its performance can be improved [15].

Cooling and heating of the battery to maintain its temperature improves its lifetime and efficiency. A cooling or magnetic liquid may be used as a means to transport the heat generated by the electrochemical cell to the cooling liquid. Examples of magnetic fluids include ferro-fluids containing $MnZnFe_2O_4$ and gadolinium, which work on the principle of the magnetocaloric effect [16]. Similarly, heat-exchanging tubes consisting of cooling liquid or gases may be placed alongside the surface of the battery. The cooling liquid moves into the heat exchange tubes near the bore of the battery cell. In an electric car, the cooling liquid can be obtained from the engine cooler of the car, making it a continuous system of controlling the temperature of the battery [17]. Alternatively, an absorption cooling device may be used as a means to cool the system by heat extraction and re-evaporation. This system uses refrigerants such as water or ionic fluids as absorbers, which absorb heat, cool the electrochemical cell and evaporate [18]. However, due to the increase in space for the placement of the cooling chamber, another alternative is to add a Peltier module. The Peltier module is used to generate a change in the temperature difference due to changes in the circuit current, alongside the battery to help reduce the temperature of the battery, which is created due to the high temperatures caused by charging and discharging [19].

Extending the durability of the battery was possible by making a compact system consisting of a Galvanic cell placed inside a cell jacket, a heat conducting unit, a cell holder, a temperature detector and a control unit. The control unit supervises the function of the Galvanic cell, while the cell holder and cell jacket protect the acid present in the battery from spilling. The heat conducting unit is suited to supply heat output to the Galvanic cell and/or dissipate it from the Galvanic cell, making the system a durable battery [20].

The temperature change in the electrochemical cell may be analyzed using a temperature sensor. A lithium-ion battery working on the Galvanic principle is used alongside a glass fiber, which acts as temperature sensor. The net of glass fibers is arranged in parallel across the surface of the separator or the cathode to analyze the temperature of the device, helping to avoid hazardous battery overheating [21]. The charging capacity of an electrochemical battery cell used in electric vehicles can be enhanced by adding sensors. Sensors, mainly magnetoresistive sensors, are placed between the active electrodes. The invention includes taking data of the parameters from the sensors placed in individual electrochemical cells and sending those data to a control unit. The control unit compares the measured values with the target values, analyzing the overall performance of the electrochemical cell [22].

To attain the proper working of the electric car, the arrangement of the cells into the batteries as well as the battery configuration are important parameters to be considered. Walter Lachenmeier has suggested the following advancements:

The battery arrangement can be carried out by connecting one or multiple batteries using interconnectors from the terminal of the batteries using a metal forming process for bending the battery terminal. The arrangement of batteries to increase the output of the electrochemical cell includes interconnection of the terminals of the adjacent batteries. The first and last terminals of the interconnected batteries are then connected to the outlets of the battery casing, making it a large battery system to operate the electric car [23].

A battery-receiving device was invented. The size of the device chamber depends on the dimension and number of batteries that are lockable and clamped to maintain the position of the battery. The multiple battery chambers containing the batteries are arranged so that thermal energy can be exchanged between the batteries, which are connected to the coolant system to maintain their operating temperature, ensuring battery performance and battery life [24]. This invention also offers the possibility of implementing battery exchange systems, which were thought by Walter Lachenmeier as being one of the most sensible solutions to increase the range of electric vehicles, which was rather restricted at that time [33][34]. Walter Lachenmeier summarized the following arguments for battery exchange systems [35]: (i) changing systems would make electric cars suitable for long journeys because the changing process at automatic stations only takes a maximum of 5 min. A long motorway journey could be interrupted several times for 5 min, but not for an hour at a time to charge the battery; (ii) rapid charging damages the battery and leads to considerable losses due to heat generation; (iii) in the magazine of the exchange stations, the batteries can be charged optimized for maximum service life. Aged batteries can also be offered because the customer only pays for the kilowatt-hour charge purchased; and (iv) the batteries stored in the magazine could really make a significant contribution to grid stabilization. Almost 10 years later, the first suppliers are currently offering battery swap stations.

Adjacent batteries may be connected to create a battery module. The batteries are arranged in the module in a cuboid shape. The advantages of the cuboid over conventional shapes include its easy planar arrangement, which saves space, its easy arrangement into stacks of modules as well as the battery cells present on 4 of its different outer surfaces of the battery stack module [25].

A prismatic electric power cell consisting of 2 current conductors with flat geometry with an arrangement of cells parallel to each other may be constructed. A hole is placed toward the surface, which is created so that the flat current conductor is in mirror symmetry with respect to the other current conductor. This arrangement provides stacking and arrangement of the battery modules to provide suitable energy storage for the electric vehicles [26]. This patent is currently the most cited invention of Walter Lachenmeier, with citations from companies such as Toyota, BMW, Mitsubishi, Samsung and LG.

A system in which cells are stacked together in series and parallel cell blocks may enhance the current and voltage output of the battery. Here, electric contacts are established by arresters and spacers using clamping devices to reduce the loss of electric energy stored in the batteries and electric devices. Similarly, the spacers are also used between different batteries to improve the electric power output of the batteries [27].

The connection of the batteries to attain a stack of batteries requires highly efficient battery connectors. A fixed battery connector was described that does not lead to chemical loss during the charging and discharging process. The contact element has at least one receiving chamber main electrode, which is open in one direction in which the contact connector is placed. To attain a compact design, the contact connectors are clamped by heating to make a fixed battery connector [28].

The manufacturing of a complete lithium-ion battery for use in electric vehicles has been developed in an attempt to create a sealed designed battery to avoid leakage, electric charge drainage and lower battery efficiency. The invented method uses an electrochemical storage cell with a sealing compound, contact element, current collector with conductive material and an energy storage unit. The sealing compounds become solid after the insertion of an energy storage cell (mainly a lithium-ion battery). This creates a protected outer cover for the battery to store charge without the issue of leakage [29].

The lithium-ion energy storage devices that were manufactured by Li-Tec Battery GmbH and in particular the flexible ceramic separators used were nominated for the German Future Prize 2007.

4. Electric Vehicles and Energy Storage Technologies

Due to his many years of work at DFG, Walter Lachenmeier was well connected to the German research landscape in the field of engineering sciences with a focus on energy technology as well as related disciplines. Following his position at Li-Tec Battery GmbH in battery development, he was offered to participate in a startup electrical car company, e-Wolf GmbH. Walter Lachenmeier was a pioneer in Germany when it came to electrical mobility: forward-looking and—as others tended to brake here—also impatient and relentless. Ten years beyond his retirement age, he still managed to inspire young people with competence and passion. These efforts culminated in presenting an extreme sports car with an all-electric drive in ultra-lightweight design at the 2009 IAA (International Automobile Exhibition, Frankfurt am Main, Germany). The e-Wolf E1 was a joint project of Leichtbauzentrum Sachsen GmbH (LZS), the Institute of Lightweight Engineering and Polymer Technology at Technical University Dresden, e-Wolf GmbH and Li-Tec Battery GmbH. For the first time, this vehicle combined an ultralight chassis made of a carbon aluminum construction with innovative flat cell technology, carbon rims, formula sports technology and road approval [36]. e-Wolf GmbH received the iF Design Award 2010 for its campaign and multimedia installation at IAA.

The final inventions of Walter Lachenmeier in this field deal with the optimization of the charging process, recuperation of energy, as well as a method for the storage of sustainably produced energy.

An increased efficiency of vehicles to supply energy has been invented using a mechanical energy accumulator (process of conversion of kinetic energy into mechanical energy) to store energy and deliver it back to the vehicle motor. This system provides a strategy to help store energy efficiently and provides energy to the vehicle when necessary [30].

Charging the battery during the operation of an electric vehicle has been suggested. The charging current is obtained by absorbing the mechanical power generated by the suspension of the motor vehicle, usually known as a shock absorber (recuperation). This system has been claimed to be suitable for use in electric and hybrid cars [31]. A numerical simulation was conducted for Intertronic Gresser GmbH (Würzburg, Germany) on the recuperation of electrical energy in the shock absorbers. In vehicles with conventional hydraulic or mechanical shock absorbers, energy drawn from the absorption of mechanical vibrations in the vehicle structure is converted into heat energy that cannot be used. However, it is possible to use linear or rotatory generators instead of conventional shock absorbers for recuperation. These can convert the energy generated by mechanical vibrations into electrical energy, which can then be used to charge a battery. The model showed that the technology can produce a significant energy yield, making it an economically viable solution for use in electric or hybrid vehicles [37].

The final patented invention of Walter Lachenmeier dealt with the storage of energy by a heat accumulator, which may be used to store energy necessitated by grid fluctuations (e.g., due to wind power and solar energy). For example, it can be applied to store energy during the day and make it available at night to charge electric vehicles. Even in the event of a temporary overproduction of “green electricity”, it makes more sense to store it in a more suitable form than to use it only to heat night storage facilities [38]. The accumulator consists of non-pressurized and pressurized heat exchangers to cool the system down using the counterflow principle. Balls were used as a medium to exchange heat. The heat is moved via the balls, which are guided to the storage tank and reservoir containing the coolant (e.g., water) [32]. Heat is exchanged through the balls to the reservoirs.

Although Walter Lachenmeier was a strong proponent of electrical vehicles, alternative energy technologies and public transportation systems [39], he also warned against exaggerated expectations and often nonscientific and physically improbable prognoses, such as “a degree of self-sufficiency in renewable energy of 123% or even 147%” claimed by scientists with industry conflicts of interest [40][41]. He was also commenting against nonsensical, unscientific claims according to which renewable energies would make electricity supply cheaper [42]. He also was against bridge technologies such as hydrogen and can be quoted: “This is also not sensible because most of the expensively generated electricity is lost on the way from the water electrolysis to the vehicle tank. Efficiency is absurdly low. Better store electricity directly in a battery” [43].

5. Public Health Research

The most recent scientific interests of Walter Lachenmeier shifted toward public health issues, possibly facilitated by his own deteriorating health conditions. He had been a strong smoker for most of his life, and his interest in harm reduction also motivated me to investigate comparative risk assessment of electronic cigarettes and heat-not-burn tobacco products [44][45][46].

We always had a strong scientific exchange in our topics, but when I participated in a 2016 working group meeting of the World Health Organization's International Agency for Research on Cancer (IARC) on the carcinogenicity assessment of very hot beverage consumption [47][48], my father became fascinated by this topic and we pooled our resources to conduct a study combining numerical simulation of heat conduction within the oral mucosa and some experimentation using a measuring spoon designed by my father, which allowed the so-far open question regarding threshold contact temperatures to avoid oral burning, which is assumed as underlying mechanism for carcinogenicity, to be answered [49].

Since the appearance of the still ongoing coronavirus disease 2019 (COVID-19) pandemic at the beginning of 2020, my father has used his modeling expertise to interpret the data, because the official reporting at that time in Germany was less advanced [50]. As there was a shortage of publicly available face masks, he devised a protocol to make masks at home from sterile triangular cloths widely available in each first-aid kit for cars according to DIN 13168 [51]. My father also had strong opinions about overpriced FFP2 respiratory masks sold to the German state due to the efforts of certain lobbyists [52]. Taking into account the growing nonscientific debate during the pandemic, culminating in corona deniers and the so-called “Querdenker” (lateral thinkers) movement, Walter Lachenmeier still had the strong belief that physicians, virologists and scientists from other scientific disciplines would be able to develop solutions from their findings [53]. Actually, my father was right in his belief. Interestingly, the BioNTech mRNA vaccine dates back to a project in a DFG-funded Collaborative Research Center on cancer research in Mainz [54]. I think my father would have said that this effort has been worth the investment of tax money.

The final paper by my father, which was again a collaboration with me, dealt with the potential to improve sleep quality in patients with severe forms of lung disease by using a low-cost wearable device [55]. This research was based on the difficulties he himself had to deal with because of his illness, namely being afraid to sleep because one could suffocate at night. He found a simple aid via the Internet and reported on its benefits. What had helped him could and should be available to support other people in similar situations.

Further Reading

https://www.mdpi.com/2032-6653/13/8/156 https://doi.org/10.5445/IR/1000029370 https://www.researchgate.net/profile/Walter-Lachenmeier-2 https://scholar.google.de/citations?user=tpkmRf8AAAAJ&hl=de&oi=ao https://orcid.org/0000-0002-6097-729X https://doi.org/10.5281/zenodo.3742674

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