TROX life magazine nov/2014

Education air.

For high marks in the classroom.

contents

viewpoint

Education is the future.

Dear readers,

Having taken over the role of Chairman of the Board of Management at TROX GmbH on 1 September 2014, I would like to take this opportunity to introduce myself to you all. I began my professional career in 1988 in the position of Sales Manager at Rosenberg Inc. in Minneapolis, USA.I then worked as Managing Director for the ebm-papst subsidiaries in Singapore, Japan and China, with each post spanning several years. Back at ebm-papst Mulfingen GmbH & Co. KG in Germany, I was Sales Manager for Asia, Australia and Africa and, at the same time, I was responsible for the EC-systems unit in my role as Business Unit Manager. Before joining TROX GmbH, I worked as Chief Sales and Marketing Officer for BITZER SE in Sindelfingen, Germany, for a number of years. Now that you have at least some idea of who I am and how I got here, I would like to welcome you to this new issue of TROX life.

It is about education. A subject that affects all of us. We cannot put a value on education. Nevertheless, declarations as to what we want from it are often in stark contrast with reality. The majority of our educational institutions are still in a sorry state. And this is even harder to comprehend, now we know that the learning environment is just as valuable to education as are the latest learning methods.

This refurbishment backlog in education provides virtually unlimited opportunities for our sector, which we should exploit together – manufacturers, designers and system installers – using air conditioning and ventilation systems that can contribute much to our children's success in education; using efficient solutions that help achieve ambitious targets in regard to air conditioning; and using contracting models that benefit both sides, for example, making it possible for the public authorities to undertake long overdue refurbishment projects despite the difficult financial situation.

As well as shedding light on other aspects, this issue of TROX life investigates just how important mechanical ventilation is to educational success. As you may expect from our customer magazine, we will also be looking at more general issues on the subject of education and educational institutions.

And how is your education holding up? Put it to the test! On page 34, we have compiled a few interesting questions from the latest PISA study. You can also complete the test interactively on our website – fun for the whole family!

As you see, TROX life educates. We hope you enjoy reading about this subject, which is important to all of us.

Michael Bauer
Chairman of the Board of Management of TROX GmbH

Controlled ventilation.

Good quality air promotes educational performance.

Studies have shown that having the best possible indoor air quality is important for educational success. Yet despite clear findings, mechanical ventilation still does not form part of the education standard.

Education is a basic right.

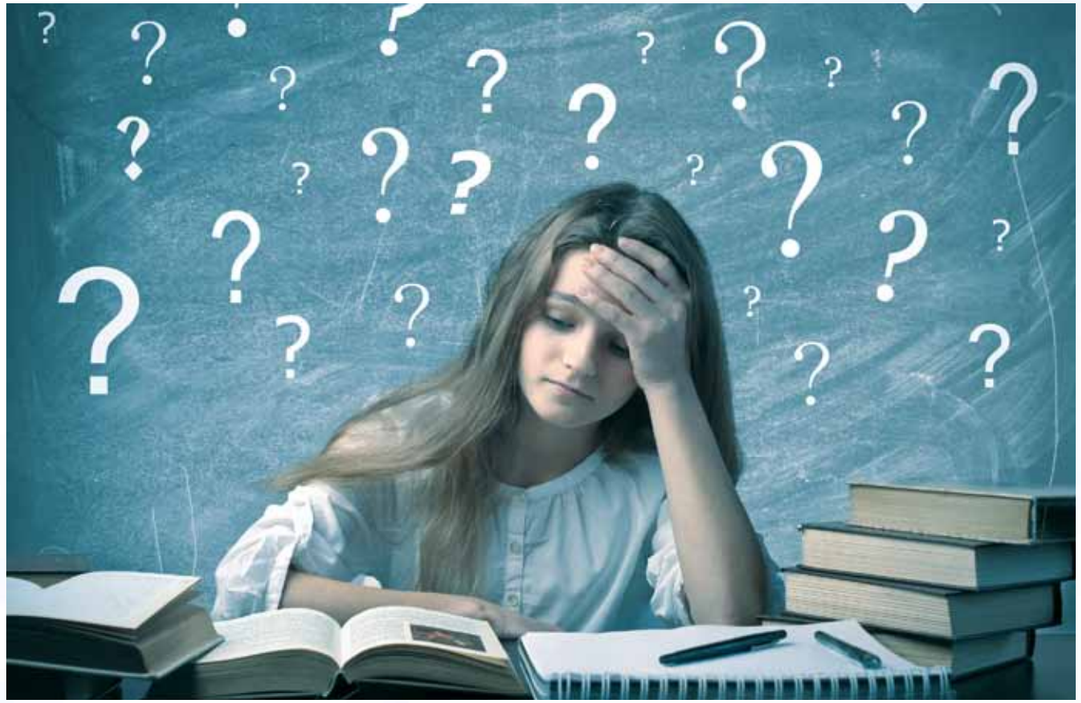
"Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit…" – this is set down in Article 26 of the UN Universal Declaration of Human Rights.

Education is the future.

Education policy occupies a position of eminent importance, and not just because education is a fundamental entitlement. Providing good education for children and young people is crucial to a country's future. "It increases the chance for economic growth and is thus an important prerequisite for fighting poverty," confirms the BMZ*, adding: "A well-educated workforce improves the quality and quantity of the working capacity of a country. Higher education and research are the foundation stone of new discoveries and innovations. As a result, they help to strengthen the competitiveness of a country and make it possible to create jobs."

So it is no surprise that, in Germany, education spending makes up 18 % of the federal budget, for example, and in 2010 exceeded 100 billion euro for the first time – even though, at just under 5 %, we still seem miles away from the medium-term goal of "10 % of gross domestic product". For comparison: in countries such as the USA, South Korea and Denmark, education spending is around 7 % of GDP.

Federal Ministry for Economic Cooperation and Development (Bundesministerium für wirtschaftliche Zusammenarbeit).



Refurbishment backlog in education.

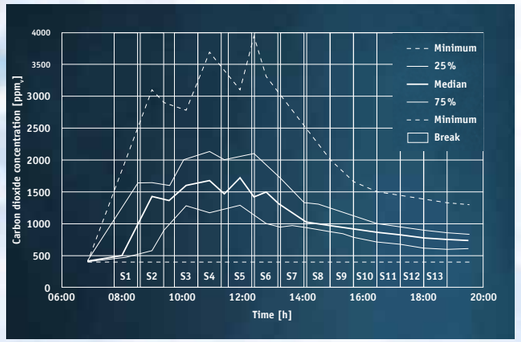
So just what state are our educational institutions in? Around half of all schools and pre-schools are in need of refurbishment. And the ambitious targets, set by climate policy, can only be achieved by pushing forward the energy-efficient refurbishment of public buildings, which still constitute 40 % of primary energy consumption.

Massive energy-saving potential.

Energy-efficient refurbishment of educational institutions would have a far more wide-reaching effect than just saving energy: a noticeable increase in performance. Introducing thermal insulation measures and an air-tight envelope would necessitate something that is proven to lead to tangible educational success: an improvement in air quality. And, according to international studies, this can only be achieved using mechanical ventilation.

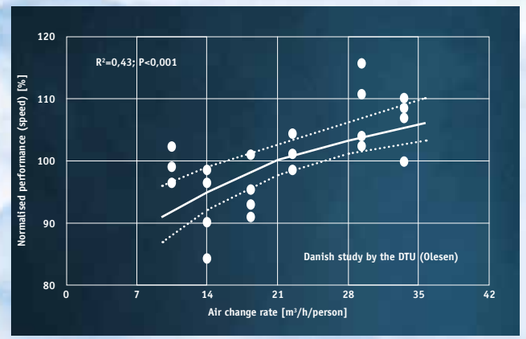
Cost-efficient ventilation.

Where there is a high density of people, there are natural boundaries on the effectiveness of opening windows for ventilation. This practice also impacts the comfort conditions of schoolchildren. Those sitting right by the window freeze, while the rest are "suffocating in the fug" – making it all the more surprising that stale air is still the norm in many schools. Investing in good quality air amounts to a little over 40 euro per child, per year. Compared with operating costs of 5,000 to 6,000 euro per schoolchild, this is negligible, representing less than 1% of the total.



Pupils spend 80 % of teaching time sitting in unacceptable room air conditions.

Source: Hellwig, R. T.; Antretter, F.; Holm, A.; Sedlbauer, K.: Investigations on Indoor Environmental Conditions and Natural Ventilation in Schools



The performance of pupils improves measurably with increased supply air flow.

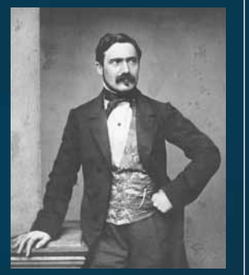
Source: Wargocki, P.; Wyon, D. P.: How Indoor Environment Affects Performance. ASHRAE Journal March 2013

Pioneers of good quality air in schools.

Measuring air quality using carbon dioxide as an indicator can be traced back to Max von Pettenkofer, the Bavarian hygienist: "The corruption of the air is not caused solely by the carbon dioxide content, we simply use this as a benchmark from which we can then also estimate a higher or lower content of other (pollutant) substances…"

He carried out a number of tests in which he measured the carbon dioxide content of the air in schools, hospitals, pubs and living spaces and compared it to the odour reported by the room occupants. The Pettenkofer value of 1,000 ppm of carbon dioxide is named after him. He concluded: "I am overwhelmingly convinced that it would substantially boost the health of our young people if we were to keep the air in school buildings, where they spend on average nearly one fifth of the day, so clean and pure that the carbon dioxide content never exceeded one part per thousand."

It is astonishing to think that even in 1884, Pettenkofer's influence led to Article 9 of an educational decree from the royal government of the Upper Palatinate region in Germany mandating that "ventilation chimneys should be created to achieve the necessary replenishment of air. These must have two openings: one near the floor and the other near the ceiling." This was the beginning of modern ventilation systems in schools.



Max Josef Pettenkofer,
ennobled to von Pettenkofer in 1883,
b. 3 December 1818 in Lichtenheim, Neuburg an der Donau;
d. 10 February 1901 in Munich, Bavarian chemist and hygienist

Stale air is the norm in schools.

Today, the reality looks sadly different. CO_2 levels as high as 6,000 ppm were measured in a school in Berlin. The result: difficulty in concentrating, tiredness, headaches, odour pollution and increased risk of infection. There is only one cure for these ills: mechanical ventilation using a room air conditioning system. Since there are usually 35 people tightly packed into a classroom, a fresh air flow rate of 30 m^3/h/person is required to reach the ideal state of 1,000 ppm of CO_2. Field tests carried out in schools paint an unambiguous picture: up to 20 % better performance.

Good grades for the AHU.

In the context of room air conditioning systems, Professor Werner Jensch from Munich University of Applied Sciences likes to quote a head teacher whose school has an old building without ventilation and a new building with ventilation: "The children in the new building perform on average half a grade better than those in the old building."

Teaching and studying in good quality air.

Commendable educational institutions.

Where students study surrounded by good quality air, components and systems from TROX are probably not far. TROX has fitted numerous classrooms, university laboratories and lecture theatres all over the world with innovative air conditioning and ventilation components.

The New Grammar School (Neues Gymnasium) in Bochum, Germany, has been awarded the Balthasar Neumann Prize that recognises exemplary, innovative cooperation efforts of architects and engineers for buildings with outstanding technical features and a superior design. In the true spirit of Balthasar Neumann.

Decentralised ventilation

New Grammar School, Bochum, Germany

Decentralised ventilation for a healthy learning climate.

200 decentralised TROX ventilation units of type SCHOOLAIR ensure that students and teachers in the New Grammar School in Bochum are always provided with sufficient ‚performance-enhancing' fresh air.

The air-water systems with heat exchangers dissipate heat loads with water instead of air – this makes them not only much more energy-efficient, they also require less space. The fresh air is heated in winter and cooled in summer, if necessary. EC fans and an integral heat exchanger for heat recovery prevent the warm room air from being extracted and exhausted unused, thereby increasing the efficiency of the entire system.

New Grammar School in Bochum.
Building owner | *EGR Entwicklungsgesellschaft Ruhr-Bochum mbH*
Architect | *Hascher Jehle Architektur*
Building services engineering | *Ingenieurbüro Krawinkel VDI-DVGW, Technisches Büro Burkhard Hörsken*
HVAC contractor | *Wärmetechnik GmbH & Co. KG*

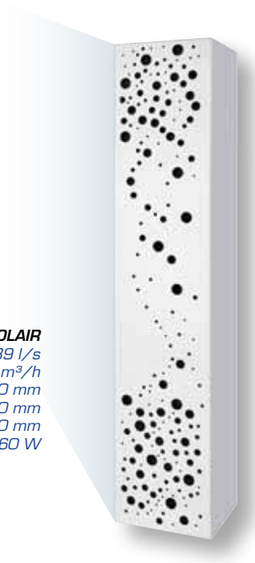
Silence in the classroom.

Silence in the classroom is no less important to the students' successfully passing exams. This is why SCHOOLAIR units have very quiet fans and ideal flow cross sections that minimise the air velocity and consequently noise emissions. Moreover, effective sound attenuation also reduces the noise from the fans.

High IQ.

Air quality and temperature sensors intelligently signal measured values to the units. Supply and extract air control is based on the CO_2 content of the room air such that high air quality is guaranteed at all times. The ventilation units are integrated with the central building management system but can be individually controlled for each room if required.

SCHOOLAIR ventilation units can be aesthetically integrated with the façade



TROX SCHOOLAIR
42–89 l/s
150–320 m³/h
Width: 400 mm
Depth: 360 mm
Height: 2160 mm
Heating capacity: *up to 4560 W*

Ideal for school refurbishments.

Flexible installation options, compact dimensions, and the fact that they operate independent from a centralised air supply make the decentralised ventilation units from TROX the ideal choice for already existing school buildings, i.e. for refurbishment projects.

Green Building goes to school(s).

While a lot of energy is ‚lost' in older school buildings that should be refurbished, the so-called Passivhaus (Passive House) standard is becoming increasingly common for new school buildings. The New Grammar School in Bochum does not only prove how attractive and striking the architecture of a school can be; it is also an excellent example for a building with a positive energy balance.

A low-leakage façade, sun protection on the outside, energy-efficient ventilation and extract ventilation, utilisation of the cool night air for cooling, and a solar heating system: With these features the school was certified as ‚Green Building' since it consumes even 25% less energy than is required to meet the German Energy Savings Regulation of 2009.

TROX DID 632
6–85 l/s
20–300 m³/h fresh air
Length: 900–3000 mm
Width: 600 mm
Height: 210 mm
Cooling capacity: *up to 2500 W*
Heating capacity: *up to 3000 W*

Air-water systems

Tahoe Center for Environmental Sciences, Nevada, USA

Text book examples of efficient air-water systems

The Tahoe Center for Environmental Sciences does research on the quality of high-alpine lakes and their surrounding watersheds.

The Center is a building which sets an example: Its energy consumption is 60% below ASHRAE standard 90.1, its water consumption 65% less than that of conventional systems. It is not surprising, then, that the building has achieved the LEED top rating from the US Green Building Council. Efficient solar and heating systems, the use of water from rain or snow, innovative heat pumps, but also TROX DID active chilled beams have increased the building's energy efficiency above average. The DIDs allow for low airflow velocities in the occupied zone and hence very good comfort levels and a low sound power level. The water for the air-water systems comes from underground cooling water tanks; heat loads are dissipated virtually without the requirement for energy. As an additional advantage the air-water systems need 40% less space than all-air systems.

In the lecture theatres of the reputable RMIT University in Melbourne DIDs also ensure good conditions for learning.

More than 500 active chilled beams from TROX provide the eleven floors of the building with sufficient supply air. The building was awarded a *5-Star Green Rating* and is used by 6000 students and 850 teachers.

Royal Melbourne Institute of Technology, Australia

In the rooms of St. John's University induction-type displacement flow diffusers of type QLCI combine a low-turbulence airflow with the energy benefits of dissipating loads with water.

The primary air is discharged through nozzles into the mixing chamber. As a result of this, secondary air (room air) is induced and passes through the heat exchanger into the mixing chamber, where it is heated or cooled. The façade ventilation systems meet the ANSI S 12.60 requirements for noise emission of 35 dBA at maximum.

St. John's University, New York, USA

All-air systems

Mohammed Bin Rashid Academic Medical Center, Dubai

All-air systems for universities.

New university buildings use also classical mixed flow systems, particularly for large air volumes. TROX jet nozzles and ceiling diffusers have found their ways into many university buildings all over the world and successfully passed all tests.

DUK and TJN jet nozzles,
circular20–835 l/s
70–3000 m³/h
Ø 100–400 mm

Lecture theater in Dubai, with TROX diffusers installed in the steps

Mixed flow systems in schools and universities.

TROX Auranor Norge has particularly interesting reference projects in the higher education sector, where buildings have been equipped with a whole range of TROX ventilation components from sound attenuators to volume flow controllers and from jet nozzles to swirl diffusers. Not only is the performance of the TROX components convincing, they also blend in nicely and aesthetically with the beautiful and unique architecture of the buildings.

Architects and specialist consultants have created very special school and university buildings in Norway as our examples clearly show:

- High School Hadeland, Gran
- High School Vaagen VGS, Sandnes

Displacement ventilation in lecture theatres.

Lecture theatres are a speciality among places of assembly. They are characterised by a very high occupancy rate (2m² per person). Then there are high heat loads caused by the high number of people. As a consequence, large air volumes are required for the ventilation of lecture theatres.

High School Hadeland, Gran, Norway

In many lecture theatres the seats are installed on steps, which can be used to accommodate the ventilation units. The air distribution ductwork can be installed in a false floor. In the Mohammed Bin Rashid Academic Medical Center (previously Harvard Medical School Dubai Center) and the High School Hadeland in Gran, Norway, TROX staircase swirl diffusers are installed in the steps on which the seating is arranged. They create a swirl that ensures efficient supply air discharge, and the displacement flow ensures very high levels of comfort.

High School in Sandnes, Norway

Education in history.

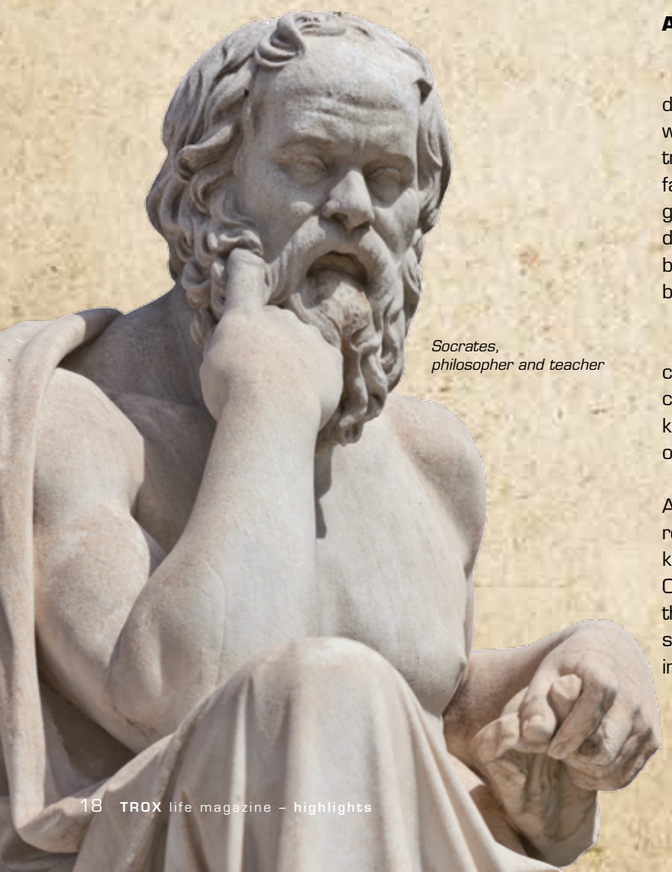
It is believed that the first schools were created **in 4000 BC** by the Sumerians. In Ancient Egypt, only the wealthy were allowed to attend school, as children of the underclass – mostly builders and artisans – were needed to help their parents with their work. Lessons included reading and writing, mathematics, geography, history, astronomy, sculpture, painting and sport.

Antiquity.

In **Ancient Greece**, the school systems in the different city states ("polis") varied greatly. Sparta, which was a warrior nation, placed its main focus on military training for young boys, while the children of wealthy families in Athens could attend schools that provided a general education. However, even Ancient Athens did not have compulsory education or public school buildings. Instead, children were generally taught at home by tutors.

In the **Roman Republic**, parents taught their children themselves. Education was therefore still not compulsory, and there were no public schools of any kind. Public schools were first founded during the time of the Roman Empire.

After the fall of the Empire, the church took on responsibility for the education system. They preserved the knowledge of antiquity and spread Christian philosophy from **Ireland** throughout the whole of Europe. Public schools were only established again in the late **13th century**.

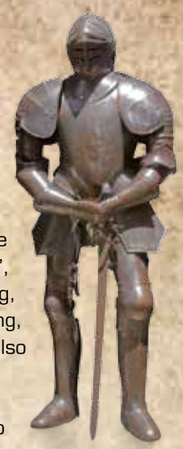


Socrates, philosopher and teacher

The Middle Ages.

Monasteries, with their expensive libraries, were at the heart of education in medieval times.

Monastic schools were divided into internal and external schools. In the internal schools, boys and girls were prepared for life as a monk or nun. Lay children, mostly of noble birth, were educated in the external schools. Teaching was carried out in Latin and was based first and foremost on religious instruction and history. This was followed by education in the "Septem Artes Liberales", the seven liberal arts of grammar, rhetoric, logic, geometry, arithmetic, music and astronomy.



The chivalric tradition, on the other hand, favoured a more practical form of education. Based on the seven liberal arts, prospective **knights** were instructed in the "Septem Probitates", the seven knightly arts: horse riding, swimming, archery, boxing, hunting, playing chess, and writing verse. They also performed the services of courtly love.

Around 1250, towns began to flourish owing to trade and commerce. Town schools grew up alongside the church-managed schools. These taught a secular curriculum and increasingly superseded the spiritual providers of education.

Sources: Wikipedia.de, Planet-Wissen.de

The oldest universities.

The University of Salerno was founded right back in the 9th century, although its status as a university is debatable. This was followed by the University of Bologna at the end of the 11th century. However, the university in its modern form did not arise until the 13th century, created by the voluntary merger of students and faculties. The sense of community was expressed using the Latin name ***Universitas****, which essentially means unity.*

Beginning of the 13th century: *Paris, Oxford, Cambridge*
Late 13th century: *Salamanca, Seville, Padua, Naples, Siena, Toulouse, Lisbon*
14th century: *Avignon, Rome, Perugia, Grenoble, Verona, Pisa, Prague, Florence, Krakow, Vienna*
1386: *Heidelberg*
1388: *Cologne*
1389: *Erfurt*
1538: *Santo Domingo, first university in the Americas*
1551: *Lima*
1553: *Mexico City*
1575: *Leiden, oldest university in the Netherlands*
1578/79: *Vilnius, oldest university in the Baltic states*
1580: *Santo Tomás, oldest university in Columbia*
1592: *Trinity College, Dublin*
1611: *Manila*
1613: *Córdoba, oldest university in Argentina*
1622: *Santiago de Chile*
1632: *Kiev*
1635: *Trnava, at that time in Hungary*
1636: *Harvard, oldest university in the USA*
1721: *Caracas, oldest university in Venezuela*
1728: *Havanna*

The modern concept of education.

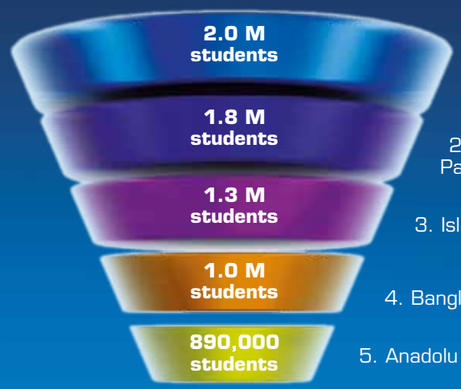
The flow of realism.

In the middle of the 17th century, the modern era broke onto the scene, and with it a new educational ideal. People increasingly saw themselves as a product of their own abilities and thoughts. Owing to insights from the natural sciences, new discoveries and inventions, it was the flow of realism (from Latin "Res" = thing) that turned away from established traditions and dogmas in favour of an explorable, demonstrable reality.

Schools were institutionalised and children and young people were increasingly educated in a methodical way.

A comprehensive public education was not introduced until the start of the 19th century, however. Child-oriented learning, matched to age and abilities, was intended to provide a general education for adolescents and prepare them for all the requirements of life.

The world's biggest universities.



1. Indira Gandhi National Open University, India
2. Allama Iqbal Open University, Pakistan
3. Islamic Azad University, Iran
4. Bangladesh National University
5. Anadolu University, Turkey

The world's best universities.

The following ranking is based on six indicators, including infrastructure, innovation, technology and art, and on surveys of 33,000 academics and 16,000 employers worldwide.

1. *University of Cambridge*
2. *Harvard University*
3. *Massachusetts Institute of Technology (MIT)*
4. *Yale University*
5. *University of Oxford*
6. *Imperial College London*
7. *UCL (University College London)*
8. *University of Chicago*
9. *University of Pennsylvania*
10. *Columbia University*

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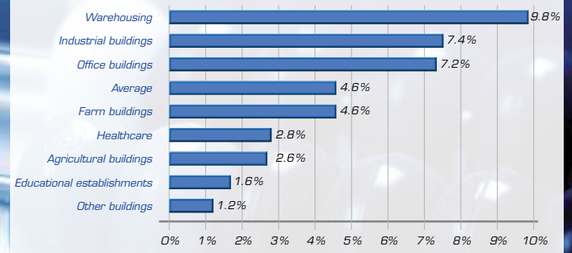
45. *Ludwig Maximilian University, Munich*
49. *University of Göttingen*
73. *University of Heidelberg*
88. *TU München, Munich*

Source: QS World University Rankings

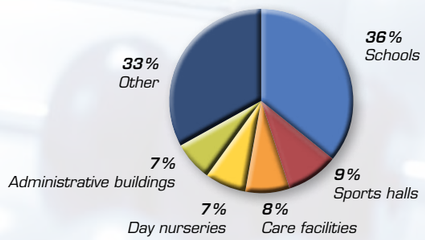
*According to legend, **Cambridge** was formed in 1209 by an exodus of lecturers and students from Oxford. It was officially founded as a college in 1284.*

Growth rates for new buildings 2014–2016 by building type



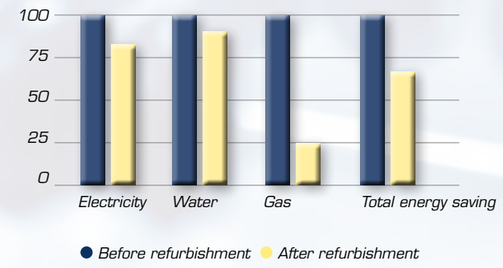
Growth in all areas of non-residential construction.

Public authorities: energy-efficient refurbishment requirements 2012–2020 by building type



The refurbishment of school buildings in Germany represents enormous potential in coming years.

Index: Savings following energy-efficient refurbishment of a school



Source: 77th EUROCONSTRUCT Conference, Oslo 2014, Bremer Energy Institute, illustrative refurbishment

Education boom.

Schools as an important driver for growth.

In the coming years, refurbishment activity will revolve around education

The importance of good education to the national economy is not contested. But educational institutions themselves also provide key economic growth stimuli, in particular for the building sector.

Schools as an important factor for growth.

Around a fifth of the volume of new buildings in the non-residential sector can be attributed to the areas of education and health, principally public building activity*. This corresponds to an annual investment volume of over 45 billion euro in the European states. Significantly greater opportunities would result from the energy-efficient refurbishment of schools that is considered necessary. Around three quarters of German educational institutions were built prior to 1977, primarily in the era of the baby boom generation of the 1960s and 70s. A study conducted by the KfW** has therefore concluded that community and social infrastructure buildings are in dire need of refurbishment. In Germany alone, the necessary investment for the period 2012–2020 is estimated to be at least 75 billion euro. By some margin, the greatest need for energy-efficient refurbishment is in schools, at a cost of around 27 billion euro. This is similarly true for other countries with social infrastructure comparable to that of Germany. For example, in the USA alone, more than 90,000 public schools were built before 1972 and are therefore in urgent need of refurbishment.

The university sector is also reporting a huge backlog in refurbishments. The German Rectors' Conference (Rektorenkonferenz) has indicated that "the initial life-cycle of many buildings is at an end". The cost of the required refurbishments to universities is estimated at around 30 billion euro.

The state is under enormous pressure. According to an EU directive***, Germany must meet the target of reducing final energy consumption by 6% by 2016. And the emphasis is on public authorities to act as a role model. This is because the annual energy costs of schools providing general education are estimated at 1.3 billion euro: making the technically feasible reductions of energy consumption result in a potential saving of hundreds of millions of euro each year.

To overcome the dilemma of the notoriously tight public budgets, in many regions this long overdue energy-efficient refurbishment is being driven forward by contracting arrangements, a win-win-win situation. The contractor funds the investments solely from the energy savings. This benefits the environment and, at the end of the contractual period, the public authorities, too.

**19 European states in the Euroconstruct Network, Oslo 6/2014.*
***Bremer Energy Institute: The Need for Energy-Efficient Refurbishment and New Construction of Social and Community Infrastructure Buildings (Der energetische Sanierungsbedarf und der Neubaubedarf von Gebäuden der kommunalen und sozialen Infrastruktur), Nov. 2011.*
****EED Directive "Energy end-use efficiency and energy services", in force since 04/12/2012.*

Diversity. The educational ideal of the Maori.

Multiculturalism down under helps pupils progress.

In education, there is one keyword on everyone's lips: diversity, a philosophy that has now spread around the world in the context of education policy. One group pioneering postmodern education methods are the native inhabitants of New Zealand: the Maori.

Diversity

The changing face of schools

Postmodern education concepts.

Universality, progress, certainty: the discovery of demonstrable truths by applying objective scientific methods is a premise of the modern age. But the paradigm shift in terms of a postmodern world view is only just taking place: according to education expert Professor Vassilios Fthenakis, innovative education concepts geared towards the postmodern reflect a world view characterised by cultural diversity and social complexity.

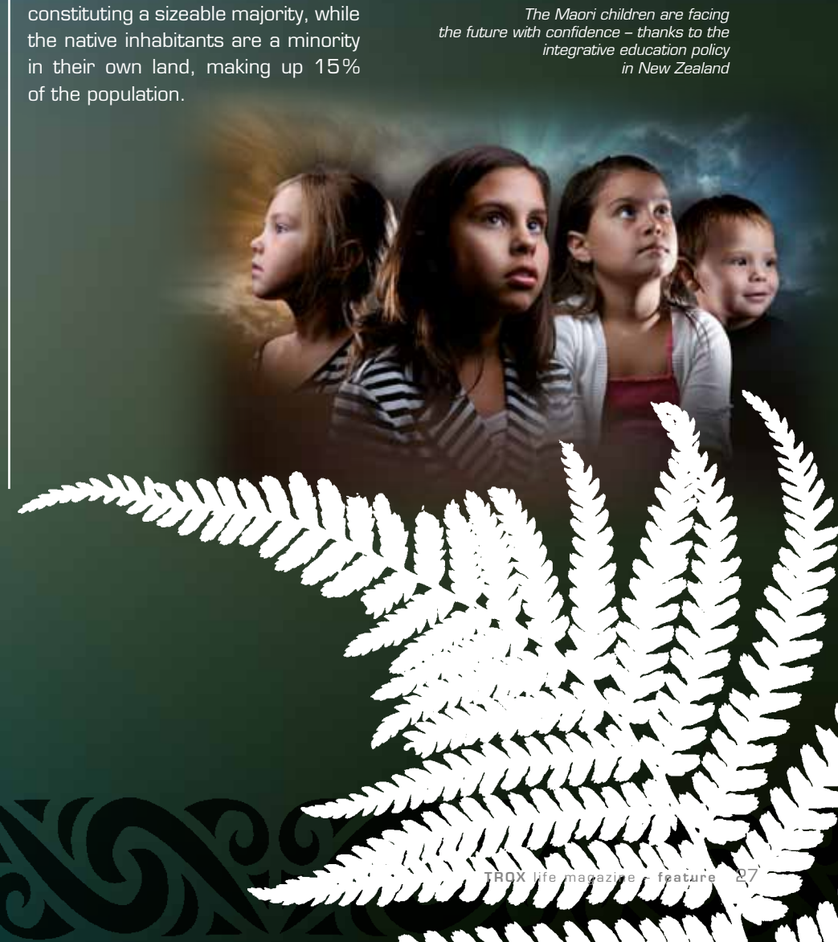
Education concepts that adhere to this philosophy exploit existing differences and see them as a rich source of experiences. Instead of "assimilation", there is a conscious attention to differences, to the strengths of the individual. The focus is no longer on the one-sided dissemination of knowledge through instruction. In contrast, children are encouraged to learn how it is that people learn and how they organise their knowledge.

At the same time, children should discover that they achieve more if they pool their strengths than they do when they work alone. Differences are seen as assets, creating a stable foundation for future educational success. These pearls of wisdom have been practised in Maori schools for a long time.

In an interview with the German news magazine Der Spiegel, football instructor Christian Streich expressed a similar, apt premise in relation to a residential football college: "In elite institutions, it is usually the strongest who come out on top in the end. The others have to show that they can be just as strong. I think this is the wrong way to go about it. It should be about developing the individuals so that they accept responsibility. The crucial point is that the team is more important than the individual. This does not mean that the individual is not important. The team strengthens the individuals, and not the other way around."

Learning from the Maori.

Just as in every country with an immigrant population, people in New Zealand needed to recognise that the education problems would not be resolved using conventional methods. There is one subtle distinction: the actual immigrants here are the white residents, constituting a sizeable majority, while the native inhabitants are a minority in their own land, making up 15% of the population.



The Maori children are facing the future with confidence – thanks to the integrative education policy in New Zealand

Diversity

The changing face of schools

Education as a social opportunity.

What was and is the source of the problems in New Zealand? The Maori were becoming increasingly marginalised in society. Customs linked to tradition had become a barrier. For example, in Maori culture it is usual for younger siblings to be quiet in the presence of their elder siblings, out of respect. This inevitably led to conflicts in school. This was because the teachers mistakenly interpreted the younger siblings' silence as a lack of interest, a lack of participation or a lack of knowledge.

Tradition educates.

The level of education among the Maori was atrocious – and to a great extent it still is today. Over 50 % do not have secondary school qualifications. The sad consequences of poor education are social exclusion and a high crime rate, as well as drug and alcohol abuse among the native inhabitants.

However, the education authorities in New Zealand soon realised that intercultural exchange presented more opportunities than risks.

In the 1980s, education concepts were already being developed – including for early years education (Te Whariki) – that gave equal weighting to the culture of the Maori and of the "Pakeha" (the fair-skinned residents). The aim is for children to grow up as competent and self-confident learners and conversationalists with a healthy mind, body and spirit, and with a sure sense of where they belong. The knowledge that they are making a valuable contribution to society gives them more confidence. All the children, not just the Maori, benefit from the strengths of both cultures. The excellent results of the "Kiwis" in the PISA study confirm the progressive education policy adopted in New Zealand.

Already living in the future.

When people talk about Maori traditions, the reader will probably have a mental image of New Zealand schoolchildren dancing the Haka. The Haka is a Maori ritual that has achieved worldwide fame thanks to the All Blacks, New Zealand's national rugby team, and which has been used to intimidate many a team before the match. And yes, traditions such as the Haka and the Maori language are being revived, too. But at the same time, schools are acquiring the latest technology and using highly innovative methods. Computer space and interactive programs, for learning Japanese for example, have been part of daily life in New Zealand schools for a long time.

In comparison, many European states are still in the Dark Ages when it comes to education.

PISA study.

Where are we going wrong?

In total, around 6250 schoolchildren in Germany took the test in April 2012; 68 countries worldwide participated in the PISA* study. The study tested performance in the subjects of natural science, mathematics and reading ability.

**Programme for International Student Assessment.*

A change of air does you good.

Every four years, the PISA study makes quite a stir in the educational institutions of the OECD countries. Hardly any other studies trigger such heated debates around the world as this one.

Although Germany has seen a major improvement compared to the 2009 results, countries in the Far East again took the top positions for education, and with a hefty lead over the Europeans. According to education experts, this is largely due to drilling by teachers and parents, and the schoolchildren's strict discipline when it comes to learning.

In Europe, it is primarily the Finns, and more recently also the Estonians, who – taking all three areas together – head the table of Europe's educational elite. TROX life has analysed the results and is on the trail of the secret to the Northern European countries' educational success.

Airing the secret to their success.

Dutch scientists have only recently discovered, as part of a field study, that concentrations of CO_2 in the classroom have a measurable effect on schoolchildren's ability to learn. In the test, pupils who were taught in buildings with room air conditioning systems had noticeably better grades.

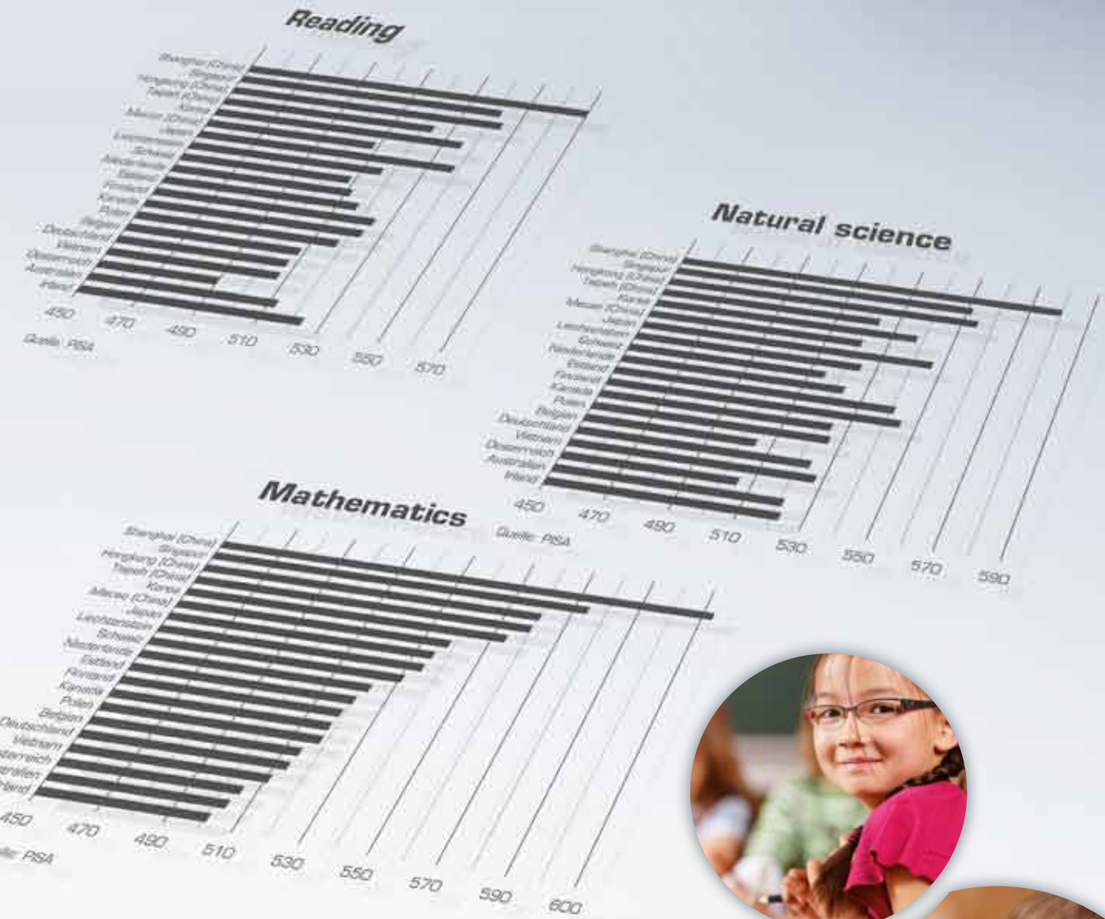
In light of this finding, ventilation experts are no longer surprised that the Finns are well in the lead when it comes to success in education. This is because – unlike in Germany – they discovered the effect of good room air quality on education for themselves a long time ago, as a result of which mechanical ventilation for schools has been fixed into building regulations in the far north. The CO_2 content is not permitted to exceed 1,500 ppm for an extended period. The Danes are following suit. A building regulation that came into force on 1/1/2011 specifies a maximum CO_2 level of 1,000 ppm for schools.

This north/south divide is not only evident in Europe, but in Germany too, albeit the other way around: the southern federal states are far ahead in terms of school ventilation, and – no longer to be wondered at – they come head and shoulders above the northern states in the PISA test.

Better education – better economic growth.

According to an analysis of empirical studies conducted by Munich professor and Ifo education expert Ludger Woessmann, "The long-term prosperity of a country stands and falls with its education." The better a country's schoolchildren perform in the PISA study, the longer the economic growth persists. Together with Stanford professor Eric Hanushek, Woessmann carried out simulation calculations and came to an astonishing conclusion: if the children in Germany could write and do maths as well as their contemporaries in the model PISA country of Finland, this would deliver economic gains for the country to the tune of 13 trillion euro over the next 80 years. That's five times the current economic performance.

And our interviewee Pawel Wargocki (see page 36), professor at the renowned International Centre for Indoor Environment and Energy (ICIEE) in Denmark, has at least one apposite suggestion as to how we can perform better in PISA: "The indoor climate in a school is just as important as the teaching methods." And teachers, the majority of whom have more than enough to do, and to tolerate, in unsatisfactory room air conditions and who, moreover, face an above-average risk of infection as a result of poor quality air, would be first in line to agree with him.



Test your knowledge.
Do the PISA test.

Five sides of a cube measuring three centimetres along each edge are painted red, the sixth face is unpainted. What percentage of the surface of the cube is red?

- Roughly 83 per cent.
- Roughly 60 per cent.

You buy two bunches of carrots. One has the leaves attached, the other does not. Which carrots will stay crunchy for longer?

- The ones with the leaves.
- Both will stay crunchy for the same amount of time.
- The carrots with no leaves will stay fresh for longer.

You have made changes to a text document and want to save the modified file while also retaining the original version of the text. What do you do?

- I move the file to a different folder before saving.
- I select the menu item “Save changes to a new file” in the text editor.
- I save the modified file under a new name.

How does the weight shown on the scales change if you drop to your knees while weighing yourself?

- The weight displayed is reduced briefly.
- Absolutely nothing changes on the weight indicator.
- The weight is displayed as higher for a moment.

To produce one complete bookcase, a carpenter needs the following items: 4 long wooden boards, 6 short wooden boards, 12 small brackets, 2 large brackets and 14 screws. The carpenter has 26 long wooden boards, 33 short wooden boards, 200 small brackets, 20 large brackets and 510 screws in stock. How many complete bookcases can the carpenter produce?

- 10 bookcases
- 5 bookcases
- 7 bookcases

The blades of a wind turbine rotate more slowly the higher the wind power plant is located above sea level, despite the wind speed being the same. Which of these reasons best explains why the blades of wind turbines rotate more slowly at higher locations, given the same wind speed?

- The air density decreases with increasing height.
- The temperature decreases with increasing height.
- The force of gravity is smaller at higher locations.
- It rains more often as the height above sea level increases.

A rectangular terrace is 5.25 metres long and 3 metres wide. 81 paving stones are needed to pave one square metre. How many stones do you need for the whole terrace?

- 669
- 1276
- 1216

For men, the formula n/P = 140 gives an approximate relationship between n and P, where n = number of steps per minute and P = pace length in metres. If the formula applies to Daniel’s walking style and he takes 70 steps per minute, what is his pace length?

- 1.10 metres
- 50 centimetres
- 70 centimetres

A pizzeria sells a pizza with a diameter of 15 cm for 15 euro and a pizza of equal thickness with a diameter of 20 cm for 20 euro. Which pizza provides better value for money?

- There is no difference in the cost/benefit ratio of the two pizzas.
- The small pizza is better value.
- The large pizza is better value.

You want to thaw your freezer compartment. This will take some hours. Where do you put the frozen food to keep it as cold as possible during this period?

- Under the duvet
- In a dark part of the crockery cupboard
- In the bathtub
- In front of a fan which is running

On the evening of 28 October 2006, you are travelling to Moscow by train. The time difference between Moscow and Germany is two hours. Both here and in Moscow, this is the last day of daylight saving time (“summertime”). How should you set your watch before your departure so that, on your arrival in Moscow at midday on 29 October, it is showing the correct local time?

- One hour back
- One hour ahead
- Two hours ahead
- Three hours ahead

How many nines will you need for all the numbers between one and 100 if you are buying single-digit stickers?

- 10
- 11
- 18
- 20

In 2001, the results of a survey of equally sized groups of heterosexual individuals of both genders indicated that men had on average 10.6 sexual partners during their lifetimes while woman had just 7. Which logical conclusion can be drawn from this result?

- Women are more faithful.
- Men are more sexually active.
- Men’s sex lives start earlier.
- The survey respondents lied.

Which way should you turn the steering wheel first if you want to reverse a car with a trailer into a parking space on the left-hand side of the road?

- All the way to the left
- Halfway to the left
- All the way to the right

What is the most effective way of reducing heating costs for a normally insulated living room without giving up your customary comfort level?

- A constant supply of fresh air
- Have the ceiling fan running
- Thick rugs
- Additional fan heater

You can also answer the questions online: www.troxtechnik.com. The correct answers are also on the website.

Air quality and the learning process.

An interview with Professor Pawel Wargocki.

Pawel Wargocki is Associate Professor at the International Centre for Indoor Environment and Energy, Department of Civil Engineering, Technical University of Denmark. He is one of the leading scientists who has investigated the effects of indoor air quality and room comfort conditions on performance in the workplace and in school.

Professor Wargocki, are you the first person to have established a correlation between air quality and educational success?

A few people before me established that indoor air quality has a substantial influence on school achievement, including Max von Pettenkofer. Our studies have quantified the effects by deducing the extent of this influence. When we completed our studies, there were only a handful of independent investigations that confirmed our results.

Is it really possible to measure this sort of thing objectively?

It is definitely a lot easier than measuring the performance level in modern office work, which is based on a wide variety of skills. Our results are based on tests in elementary schools and relate to fundamental skills such as reading, text comprehension and mental arithmetic. It is then up to the teachers to judge whether the expected advances in learning have been demonstrated. Quantifying creativity and similar skills may seem a lot more complex. However, these form the fundamental basis of all learning processes. All the same, there are a number of small but important details that must be borne in mind when measuring the performance of schoolchildren:

- *The tests should be part of the usual class routine without the schoolchildren knowing that they are participating in a test, or else they will respond differently. For example, the younger children could try to perform especially well, while the older children, if they react at all, will not pay particular attention to the problems set. In both of these cases, this behaviour will lead to non-representative results.*

Professor Pawel Wargocki, Associate Professor, Technical University of Denmark

- *Everything must run as normal in terms of time schedule. And the tests must be carried out by the usual teachers – it is best if the researcher has no contact at all with the children.*

- *It should be possible to measure educational performance objectively, e.g. based on the speed or accuracy of the solution. Ideally, the tests should be developed in cooperation with the teachers. We initially practised our tests in other schools, and modified them based on the feedback from the teachers.*

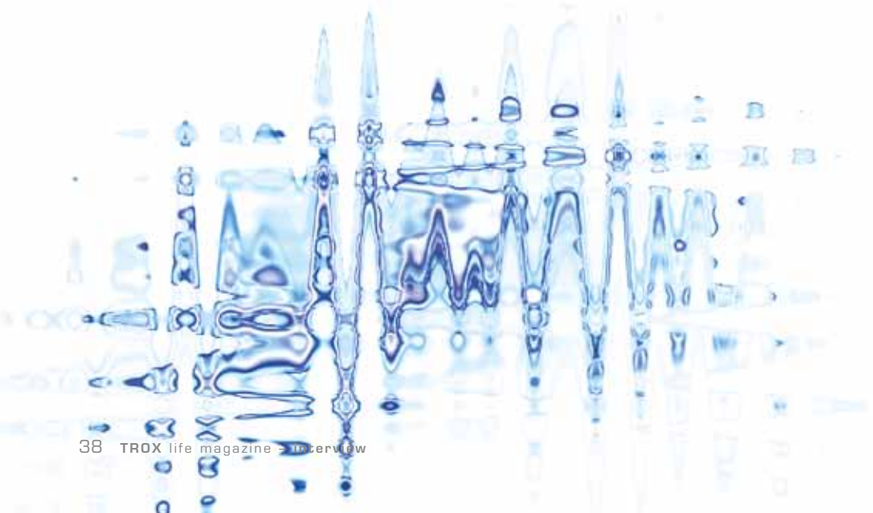
Can you describe the result of your study for us in simple terms?

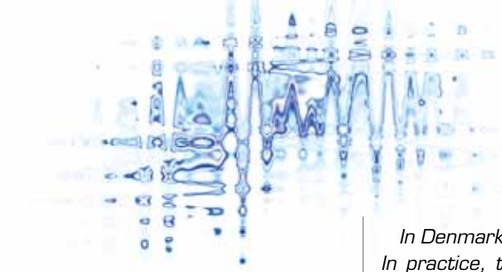
We observed that, by doubling the fresh air flow rate, the speed at which arithmetic problems were solved increased by up to 14% on average. However, we were unable to establish an influence on the accuracy of the test results. This effect is many times greater than anything we were able to observe by increasing the fresh air flow rate for adults in offices. We were really stunned by how high the value was. I should mention here that the fresh air flow rate is representative of the improvement to the air quality in the classroom. We kept the room temperature constant during the tests so that this did not influence the results in any way. Our studies were carried out in rural areas, so the quality of the fresh air was correspondingly good. It is also worth mentioning that, at 10 l/s per person, the fresh air flow rate was actually lower than that usually taken as a basis for offices.

Are you in a position to identify consequences from your findings?

We most definitely are, but certainly not to the extent that we had privately hoped. Nonetheless, awareness of the importance of air quality in schools has increased. People know about the negative effects of poor quality air on educational success, and about the long-term economic implications.

Mechanical ventilation in schools is being discussed, especially in the context of the need to reduce energy consumption in buildings. As I understand it, systems that contribute to an improvement in air quality do not entail higher energy costs as long as they are designed and installed using the latest technologies. And actually, the cost per person for generating higher quality air is much lower than the cost of a lunchbox, for example.





In Denmark, the building regulations require a statutory minimum ventilation flow rate. In practice, this means that where new school buildings are constructed or schools are renovated, mechanical ventilation systems will usually be installed. Hybrid systems also seem to have achieved acceptable results in Denmark. We recently completed a project designed to analyse different ventilation systems in Danish classrooms. The performance of the systems was assessed not only in terms of air quality, but also with regard to energy efficiency and design. Both mechanical and hybrid ventilation systems achieved top ratings. High room air quality leads to yet more positive effects. For example, researchers at the Lawrence Berkeley National Laboratory in the US have discovered that good quality air results in fewer absences among schoolchildren.

We have also tried to estimate the impact in terms of the economic effects of better school achievement. These are significant, but cannot be measured immediately; you need to wait until the schoolchildren have finished school or university and entered the world of work. We still have a lot to learn on this subject, but one thing is clear: the learning process should not be made more difficult just to save energy. School buildings should therefore be designed to provide the best possible conditions for learning – which quite clearly includes the room air quality, too.

What do you propose?

We need to provide more clarity for policy makers and school authorities. Additionally, more extensive studies would certainly help us in this process because they strengthen our argument and give us an indication of which long-term educational successes can be achieved and how coughs and sneezes can be kept at bay. So I very much appreciate the fact that this magazine is addressing this subject which is so important to all of us. Not least because it affects the future of our children.

Space-saving and efficient by using water as energy transfer medium. Decentralised air-water systems ensure a performance-promoting environment in schools

Can your findings be applied to other areas?

Of course! It has long been proven that a good IAQ (Indoor Air Quality) in office buildings not only improves worker productivity, but also their satisfaction. This, in turn, leads to improved efficiency. The impact of this on the national economy cannot be overestimated, as the most expensive commodity in an office building are the people who work in it. As has been proven, a higher air change rate leads to reduced absence rates among employees, thus creating an annual benefit to the economy of approximately 300 euro per person. Similar effects are to be expected when it comes to efficiency and productivity. We must therefore consider that making cost and energy savings of a few per cent usually entails disproportionately higher losses because the employees cannot deliver the desired performance.

Professor Wargocki,
thank you for your time.

3D. Measuring techniques.

Investigating indoor airflows.

Measuring airflows in internal spaces is very difficult due to the size of the area to be measured. Using established methods such as omnidirectional velocity probes which record the airflow velocities at one location, measuring the average airflow velocities can sometimes take several hours, or even days. This depends on the fineness of the measurement calibrations chosen to investigate the airflows in the space.

The measured velocities are averaged over time for the purposes of analysing and illustrating the measurement results.

Using Particle Tracking Velocimetry (PTV), a camera-based velocity measuring technique, it is possible to carry out a time-resolved experimental study of room airflows in large spaces. Tracers are added to the airflow to make it visible, as in most optical flow measurement methods. In the measurement process illustrated, the system comprises four cameras with a resolution of 5.5 megapixels and an adapted computer system which can continually record the image data even at high picture rates. The camera's field of vision is illuminated using high-performance LEDs.

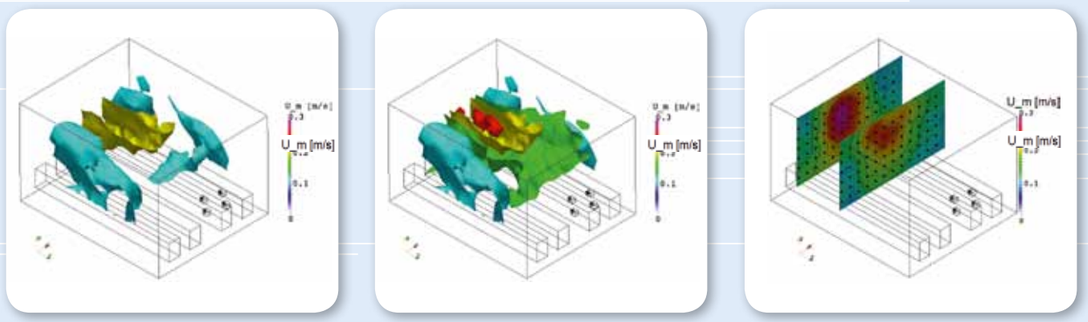
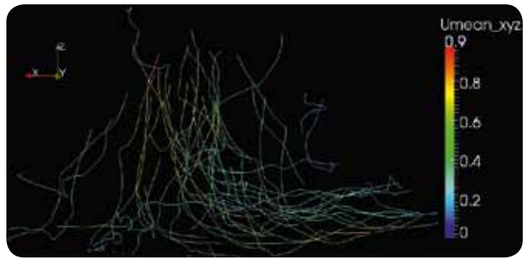


Illustration of the average airflow velocity of probe measurements carried out at the Institute for Energy Efficient Buildings and Indoor Climate at RWTH Aachen University.



Computer evaluation of the recorded images.

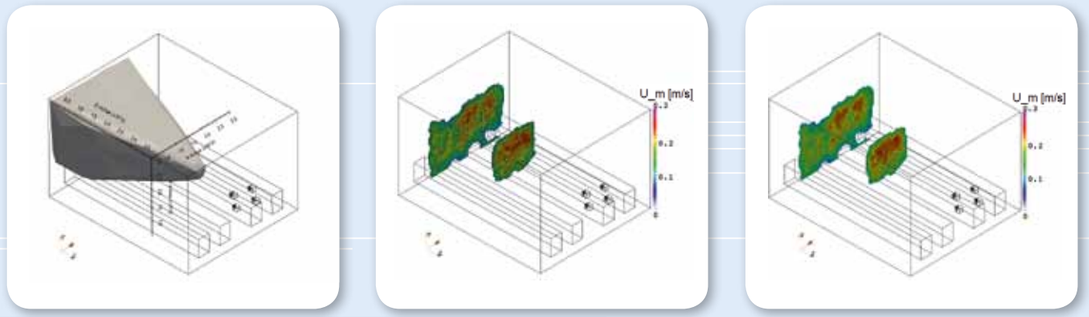
In the case of 3D-PTV, several cameras simultaneously record the tracer particles, in this case helium-filled particles of neutral density, added to the flow. By reconstructing the position of the particles in the measured space and by following the movement of the particles over several time steps, it is possible to determine the particle "trajectories" for further investigations and to compare them with data recorded previously.

The images recorded during a sequence are evaluated by computer. Individual particles can be identified in the images and their position in the room determined for each time step. This method can be used to reconstruct and evaluate scatter. During tracking, the displacement of the individual points is analysed and the movement of the tracer particles is established. The trajectories determined in this way are used in the analysis of the room airflow (see picture to the left).

3D-PTV, three-dimensional particle tracking velocimetry, is used in the Model Room at RWTH Aachen, Germany, to investigate the development and unsteady behaviour of flow structures. Scientific research projects applying this measurement methodology have also been funded by the Heinz Trox Foundation*. A major advantage of the 3D-PTV technique is the size of the space that can be recorded during a measurement. Previous investigations were able to take measurements over volumes of up to 9.5 m³ (cf. picture, bottom left).

3D-PTV

Three-dimensional particle tracking velocimetry



The measured data are post-processed in such a way that they can be compared with the probe measurements or the calculation results from numerical methods.

***TROX educates. The Heinz Trox Foundation.**

First and foremost, the Heinz Trox Foundation was founded to secure the continued existence of the company. Balanced against that is the foundation's aim of promoting basic research in the area of air conditioning and ventilation technology. Since it was founded, 2 million euro has already been used to support scientific work as well as for charitable projects.

World first:

A jet nozzle with shape memory actuator.

TROX is the first company in the world to market a jet nozzle with shape memory actuator (SM).

Shape memory alloys (SMA) have a special property that means that, following plastic deformation, they "remember" their original shape and, as soon as the temperature changes in a particular way, they resume this shape. This resilient behaviour means the SM element is capable of doing mechanical work as a result of a change in temperature, for example performing an actuating motion. This eliminates the need for a motor actuator and complicated wiring.

Owing to the method used, SM materials are extremely expensive. Components or solutions for particular applications are therefore not readily available. In general, these are associated with costly new developments.

While looking for alternative, temperature-dependent actuating options for air terminal devices, and in particular for the newly developed jet nozzles of type TJN, the development engineers at TROX got to work with SM materials. The expansion material actuators used previously react very slowly to changes in temperature. Moreover, they require a lot of installation space and thus present a design challenge when it comes to integration into air terminal devices.

SM actuators open up entirely new opportunities. The relatively high cost of materials and the significant outlay required on development means that, so far, shape memory alloys are only rarely found in standard applications. However, their particular characteristics make it possible to develop smart, innovative solutions for specific applications, such as in the healthcare and automotive industries, and also in building services. TROX is using innovative SMA technology to open up completely new opportunities in the development of innovations for both new and existing products.

TROX jet nozzle
with shape memory actuator
[Type TJN]

TROX acquires new sales partner in Eastern Europe.

International market presence strengthened by divisions of BSH Group.

Vienna, 22 May 2014:
With the goal of strengthening the international market presence of the TROX GROUP, TROX acquired parts of BSH Luft + Klima Geräte GmbH, Vienna, one of the leading companies in the ventilation and air conditioning industry in Austria and in the emerging markets of Eastern Europe.

The newly acquired divisions and companies generated sales of approximately 20 million euro in 2013. In future, the wholly owned subsidiaries will sell the TROX product portfolio. They will be trading as BSH Technik Austria, BSH Technik Poland, RC Poland, BSH Technik Hungary and BSH Technik Czech Republic, and will be responsible for Austria, Poland, Hungary, and the Czech Republic, respectively. The businesses belonging to BSH International, Vienna, with operations in Azerbaijan, Kazakhstan, Ukraine and Georgia, will remain with the current owner.

Evaluating the deal, Udo Jung, Managing Director of TROX TLT GmbH and BSH Polska Sp. z o.o., says: "The acquisition provides a logical extension to the TROX product portfolio in the form of refrigeration products, among others, and gives us the opportunity to develop additional markets. Our goal is to further strengthen our market position as a system provider in the growth markets of Eastern Europe."

BSH AIR TECHNOLOGY TECHNIK

About BSH GmbH:

BSH was founded in 1978 as an independent privately owned spin-off from the former Babcock-BSH subsidiary in Austria. The product range, which originally comprised just fans, has been continuously expanded over the years. Operations developed an international focus with the founding of subsidiaries in the EU member states of Hungary, Poland, and the Czech Republic.

Culinary schools take root.

Learning haute cuisine.

Culinary schools are springing up like mushrooms all over the world. The possibilities are virtually endless, from preparing Tuscan pasta specialities to discovering the original recipe for a Thai curry. You can even be "apprenticed" to some of the most prestigious chefs in the world. Amateur cooks can learn the intricacies of molecular cuisine from Spanish chef Ferran Adrià, one of its founders. In the Culinary Academy at the famous Raffles Hotel in Singapore, you can likewise be instructed in the secrets of Asian cuisine from top chefs. Already, entire holiday packages to Asia are based around the preparation of delicious dishes. A 14-day wok trip, for example, guides you through Chinese cuisine from Canton to Beijing.

The Culinary Institute of America is the oldest and most prestigious culinary school in America. Star French chef Paul Bocuse has even called it the best professional culinary school in the world. There are 2,700 students registered for the courses in "Culinary Arts" and "Baking & Pastry Arts", at a cost of around 18,000 euro for each year of study. Alain Duca sse, Daniel Boulud, Gray Kunz and Roger Vergé have already shown the CIA what they are made of. The list of 40,000 former students reads like a Who's Who of the cooking world.

Probably the most distinguished international professional culinary academy of them all is the "Cordon Bleu". With 27 locations in 15 countries and around 18,000 students, it holds the leading position worldwide. The name comes from the "Knights of the Holy Spirit" – the sign of the order was a golden cross on a sky blue ribbon. The knights regularly came together for celebratory banquets, giving rise to the culinary metaphor of the cordon bleu in French: un *repas de cordon bleu* ("a delicious feast") or *être un véritable cordon bleu* ("to be an outstanding cook"). The dish of the same name, a breaded cutlet of meat stuffed with cheese and ham, can also be traced back to the blue ribbon of the order.

I have never let my schooling interfere with my education.

Mark Twain

"Non vitae sed scholae discimus."
We do not learn for life, but for school.

Senecas, 4 BC – AD 65

"Non scholae, sed vitae discimus"
We do not learn for school, but for life.

Quoted by teachers since the 13th century

The youth of today love luxury, have bad manners, and disrespect authority.

Socrates, 470–399 BC

There is only one thing more expensive than education: no education!

John F. Kennedy

History is the best teacher with the most inattentive pupils.

Indira Gandhi

I'm raising my daughter the anti-authoritarian way, but she still won't do what I say.

Nina Hagen

It is better not to be taught at all than to be taught badly.

Proverb

Education is what remains after one has forgotten everything he learned in school.

Albert Einstein

It's better to have an hour of school than no sl eep at all.

Graffiti

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