tech.mag

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NEW IDEAS AT A GLANCE

ebmpapst

Editorial

Dear customers, partners and friends of ebm-papst,

You all know ebm-papst as a highly innovative enterprise, always the one decisive step ahead of its competitors especially in terms of technical details and ideas. This is the road to success we will continue to pursue, and along the way, we shall deal with all those competitors trying to save R&D expenditure by only producing slavish copies of our high-quality products.

We are driven by a keen desire to be able to offer you, our customers, our innovative products at exactly the right point in time to allow you to also be, with your products, the decisive step ahead of your competitors.

This is why we muster all our innovative strength and resources to be able to meet the technical challenges of the future – in close co-operation with you! We also firmly believe that we are able to influence future developments to no small degree. This is why we use integrative planning and development in pursuing a strategic product planning right through to the optimal market launch of our products. Taking note of such key factors in shaping a successful future, we and our customers are pro-active pioneers – leaving behind those who only react to us or copy our products.

Figuratively spoken, our R&D crew is constantly casting lassos to the future, thus hauling innovations into our labs.

So take this issue of tech.mag to cast an eye in our "workshop for the future", allowing you to view what innovative ideas our engineers have recently come up with.
Enjoy!

„ebm-papst – making sure you are the one decisive step ahead of your competitors!"

Thomas Philippiak
Managing Director
ebm-papst Mulfingen GmbH & Co. KG

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EC fans cooling the new ice pavilion in Dresden

In 2002, when the disastrous Elbe flood had receded, the Semper Opera House, the Dresden Zwinger, and the old ice pavilion situated in the Ostragehege in Dresden were found to be badly damaged. And whereas the restoration works to the cultural monuments have been concluded by now, the sports facility is still being worked on. This is because the ice racing track is situated right in the middle of the bayou northwest to the inner city. To prevent future flooding, the city planning authority and the subordinate water board had demanded the relocation away from the current of the bayou even before the August flood struck. A new and modern hall is being built to comply with this demand. Right now, a big functional building containing two ice rinks (30x60m) for competitions and popular sports events, an attached hall for ball sports and a functional building for other sports are being set up. These buildings are owned and operated by the Dresden 'Sportstätten und Bäderbetrieb' authority (the board of sports facilities and pools). The project has a volume of € 23 million and is scheduled to be finished and ready to use by the beginning of the 2007 season. About € 14 million of this investment are flood money coming from the Free State of Saxony, money bound to dry up by the end of 2006. This deadline determined the financing period. The rest of the money is made up of sport sponsorship and state funds.

Fig. 2: The condensers are fitted with four ebm-papst EC fans each.

Refrigeration and cooling systems operative as of October

The modernised refrigeration and cooling system will be ready for operation as early as October 2006. This is when the open air season of the ice racing rink is due to start, lasting five months until March, as in the past five years. After the four refrigeration units had been successively reduced to two, the AIC engineering company in Chemnitz was asked to modernise the old electric-powered control room of the two-step NH_3 refrigeration plant in the spring of 2004. AIC had handled this refrigeration system for years. At the same time, an architectural competition was held for the new hall. "In talking to the operator, we suggested to integrate the operation of the ice racing rink into the necessary new refrigeration system of the ice rinks in the hall, rather than having two separate systems operate in such close proximity.", says Dr Egbert Thümmler, Head of Technical Equipment at AIC. "In the end, we managed to prove to them that one new refrigeration system for three skating rinks would be less expensive, both in terms of investment and running costs, than modernising an old one and operating this modernised one together with a new and smaller refrigeration plant. And so there were no factual reasons why they shouldn't go along with what

Fig. 1: Planning computation of the finished building

EC fans cooling the new ice pavilion in Dresden

”EC fans are quiet and you get a far better efficiency“

we suggested.” The order was finally placed with AIC. Planning started as of Easter 2005. In addition to this, AIC was also commissioned to plan heating, ventilation and sanitation – a development that turned out to make a lot of sense later on.

Special features of the refrigeration system

Once the project is finished, all three ice rinks are operated by one common NH_3-refrigeration system. The first surprise came early on in the planning stage of the three rinks located at the existing engine house. Designed in the GDR times, the building shell had been fitted with apertures for conveying the air of the heat exchanger, yet they were later closed with wooden lagging. Only when examining the old blueprints was this revealed. At first glance, this offered itself for a solution relying on evaporator and condensers and an air intake via outer wall and air discharge on the roof. Based on data (hourly details on temperature and humidity) for three different years provided by the German Weather Forecast Agency for the location allowed the planners at AIC to exactly calculate the potential operation demands. An important aspect: The specifications laid down by the operator (Sportbäder Dresden) for the actual usage of all three rinks were also taken into account and the result was then compared to a scenario relying on the use of dry coolers, fitted with modern EC fans made by ebm-papst Mulfingen. Result: Dry coolers are far more economical for this project. There are two major reasons for this:

1. Setting up a total of seven condensers poses no architectural problem, as the engine house is already designed to accommodate such a system.
2. The ice racing rink has no roof and is only to be in operation from early October to the middle of March. Rising temperatures outside reduce the ice rink space to be cooled to finally just one rink at the height of summer. The evaporation effect would then be at maximum – if it wasn’t for the fact that it is made use of in the cooling system. As the condenser side of all three rinks is brought together, all condensers can nonetheless run at partial load, too. The control concept of the EC technology makes it easy to operate every single one of the 32 fans in continuous closed-loop control. Thus, the entire condenser space can be optimally used to ensure the specified set values are kept at minimal use of energy of the fan motors.

“For preparing the ice, we have found a solution with dry condensing and direct evaporation of the NH_3 coolant, a solution which renders the entire expenses of the water side of things respectively water treatment for evaporation cooling superfluous”, explains Dr Thümmler, planner for this project. “The three large ice rinks become especially economical when taking into consideration the summer operation with only one ice rink to be cooled. For this, a control system is needed that makes optimal use of the entire condenser output installed, i.e. the complete surfaces of the dry condensers. As the cubed fan speed is linked with the power input, the economical EC operation results in lower energy costs. Moreover, the ΔT air intake/discharge is low. The condenser temperature is rarely more than 35°C, even in summer, which also reduces the operational costs of the refrigeration plant.”

EC fans are quiet

Another important aspect for the planner was quiet operation. “It is possible to run the system at partial load day and night with low noise emissions of the fans. Complying with the limits set forth in the BImSchV (building emission protection regulation) poses no problems with EC operation. There is no humming noise as is often the case with phase angle control. And compared to closed loop speed control in AC technology, we get a far better efficiency here in Dresden.“

And another aspect often noticed far too late in direct comparisons made AIC go for EC fans: The time and money spent on wiring is substantially less than with closed loop controlled AC motors, and with 32 controllable EC axial fans (Ø 800 and 990 mm) on the seven condensers, redundancy is automatically given. With three-phase or AC asynchronous motors, a number of frequency inverters would have

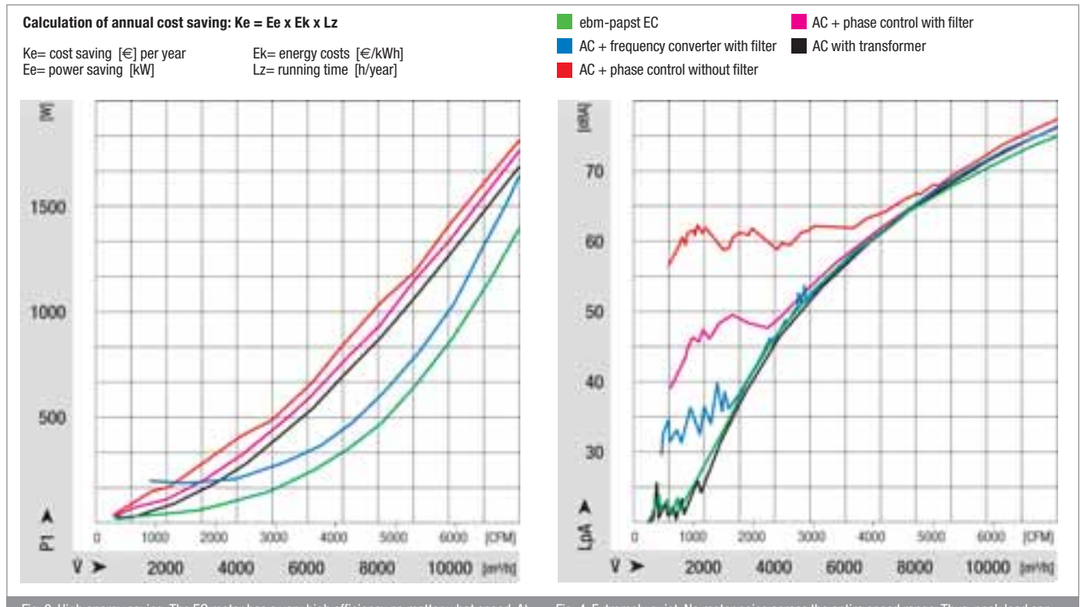

Fig. 3: High energy saving: The EC motor has a very high efficiency no matter what speed. At nominal speed, there is an energy saving of approx. 10%. In controlled operation, relative and absolute savings are substantially greater.

Fig. 4: Extremely quiet: No motor noise across the entire speed range. Thus, peak load can be run whenever there is high demand for refrigeration. When less refrigeration is needed, e.g. during the night, very low speeds can be chosen to make for quiet operation. The resonance typical for fan unit operation, or the “phase angle hum” do simply not exist due to the design principle.

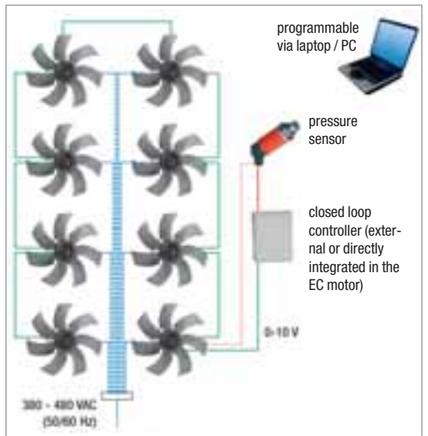

Fig. 5: New master-slave system (group control) with EC motors.

been necessary, ad this would also have to be taken into account when doing a direct cost comparison. Here, the complete condensers were supplied by thermofin including the control electronics.

Inexpensive and energy-conscious

In terms of investment, EC technology proved to be the most cost-effective solution in the end, as ebm-papst as manufacturer had promised it would. Independent comparisons made in the course of the tendering had also shown this to be the case. “During the tendering phase, bidding parties were still hunting for cheaper alternatives – without success. In the end, there was no offer that could compare.” According to Dr Thümmler, there are only a few applications left today where AC fans might still be the better alternative.

The fact that AIC was finally responsible for heating, ventilation and sanitation made it possible to have integrated planning from an early stage on. The oil cooler warmth of the screw-type compressor aggregate can be retrieved on a temperature level of 55 to 60°C in order to be fed into the heating supply of the halls. The heating system operates on a low temperature track (up to 55°C) and a high temperature track (up to 75°C). The waste heat from the refrigeration process is used for the following applications:

1. Service water heating for ice production
2. Defrosting pit of ice wear debris
3. Service water sanitation
4. Under-floor heating of social areas & facilities

The production of warm water takes place in two steps. First, there is a preheating via low-temperature of the recovered heat. The rest is done by a gas boiler. Just for the records: The filling quantity of the coolant for the direct-evaporation refrigeration plant is 18 tons of ammonia. The plant is located in close proximity to the Magdeburger Strasse, a residential area. Still, using this coolant was never disputed. And the Old People’s Home directly opposite was mainly responsible for strictly complying with the noise emission regulations. Thanks to the EC fans operating quietly as a whisper, these specifications were easily met.

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Project engineer / Domestic sales
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EC fans cooling the new ice pavilion in Dresden

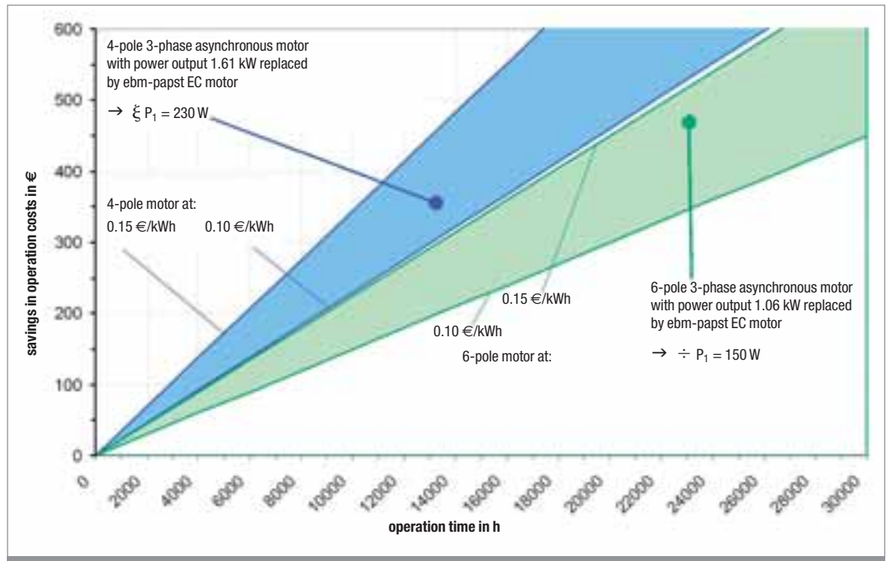

Fig. 6: Savings in operational costs when using an EC motor across the service life for different energy costs.

N.B.: First published in the specialised HLH magazine in October 2006 including an interview with Dr Thümmler

Robot assembling large fans for the first time

When producing large fans, a lot of cost-intensive manual labour has been required so far. With an increase in quantity, these production steps can be automated economically. However, a classically automated flow production is far too rigid; Large fans are far too individual and have too many variants to allow for such a production. Now, ebm-papst Mulfingen has found a pioneering solution for their production: A flexible industrial robot able to handle any existing variant as well as future product optimisations or new designs.

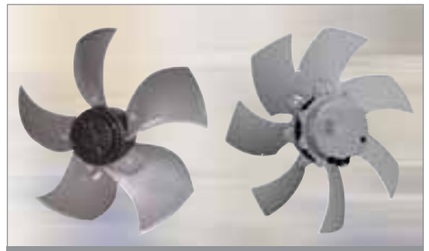

Fig. 1: The powerful AC-fans (left) or EC-fans (right), sometimes as heavy as 45kg and with diameters of more than 1m, have to pass a number of assembly and inspection stations before finally leaving the factory thoroughly tested.

At their plant in Mulfingen, ebm-papst manufactures centrifugal and axial fans in a performance range of up to 3 KW. Depending on the application requirements, these large fans are powered by either EC- or AC drives (fig. 1). They are used, for instance, in heat exchangers for air-conditioning systems in industrial plants, supermarkets or storage buildings, as well as in climate cabinets for mainframe computer systems. Production and assembly of these powerful fans and blowers are highly demanding. These AC- or EC Giants are sometimes as heavy as 45 kg, some have diameters of up to 1m, and they all have to pass a large number of assembly and testing stations to guarantee they are thoroughly checked before finally leaving the factory. Rising quantities and ever increasing numbers of variants plus usual consideration of very individual customer specifications have necessitated the restructuring of production sequences for final assembly.

Centrally placed robot serving production cells

At the beginning of 2006, the partly automated and labour-intensive assembly line, requiring muscle power at some stations when transporting the heavy raw parts and customary for final assembly, was replaced by a modern robotic system. This solution is tailor-made for use in fan production and was developed by a specialist in robotic handling systems and industrial software, in close co-operation with the production specialists of the fan manufacturer. It is based on a serial six-axle Kuka cantilever robot (KR210 L180) placed right at the centre of the individual processing stations, serving them in the appropriate sequence depending on the product in question and the processing stage (fig. 2, right).

"As the robot can be freely programmed, there is great flexibility in terms of managing the assembly sequence. With centrifugal blowers, for instance, there are no blades to be assembled; The processing station designated for this is then simply skipped. Moreover, the robot system itself doesn't take up much space!", is how Heiko Scheu, Production

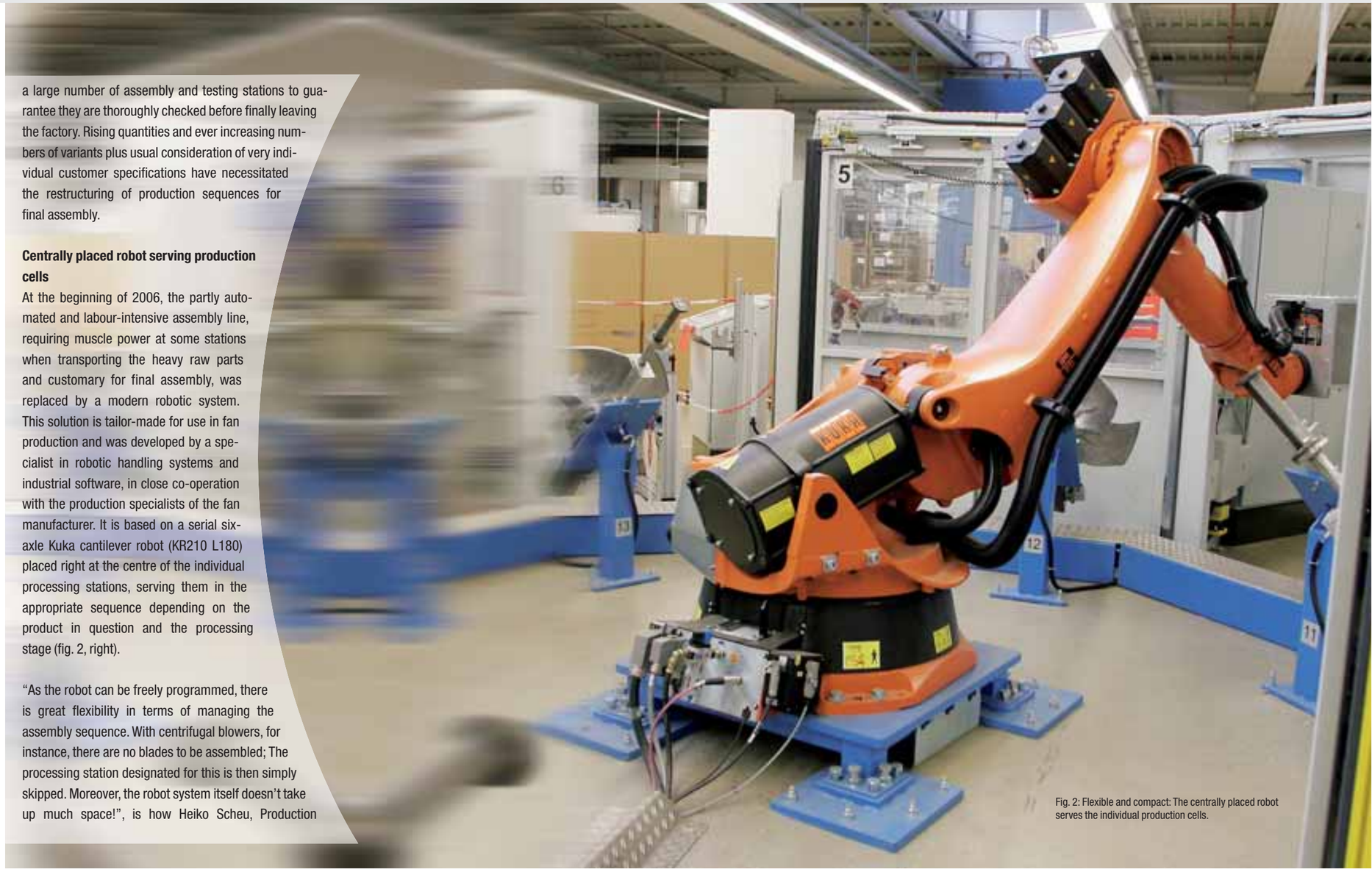

Fig. 2: Flexible and compact: The centrally placed robot serves the individual production cells.

Flexibility is keyword in modern production: Robot assembling large fans for the first time

”Power & Free systems cannot compete with the new robotic plant!“

Manager PG2M at ebm-papst Mulfingen, summarises the main advantages of the robotic system. “Possible alternatives such as work-piece tray assembly line or Power & Free handling systems mounted on the ceiling cannot compete with this. Assembly line systems are clearly more space and cost intensive, Power & Free systems are definitely less flexible”, concludes Heiko Scheu. An important point in favour of the new robotic plant was the guaranteed functionality in future. Whenever a new variant or even an entirely new product using another production sequence has to be manufactured, all it takes is a modification of the software.

Fig. 4: Processing station for blade assembly.

Optimal sequence of production steps

In principle, the sequence of final fan assembly in the new robot system is easy to understand. All the components needed for the fans, e.g. rotors and stators, are supplied, assembled and mounted on a work-piece tray (fig. 3, see below) before being accepted by the robot and transported to the next processing unit. In doing so, the work-piece tray holding the fan is supplied at each processing station in the position that is optimal for this processing step.

With axial fans, for instance, the first processing station served by the robot is the blade assembly as mentioned above (fig. 4, left). Once the blades are screwed onto the rotor of the external-rotor motors, the robot takes over the work-piece once more in order to now head for the balancing station. Here, the fans are balanced in two planes and, if needed, balancing weights are attached (fig. 5, see below). The next processing station takes care of all electrical, functional and acoustic tests (fig. 6). In case there are any defects or failures, the samples under test are first discarded, then repaired and finally subjected to yet another round of tests.

Fig. 3 : Assembly of the supplied stators and rotors on a work-piece tray accepted and then handled by the robot.

Fig. 5: Balancing and fixing of the balancing weights.

Fig. 6: Testing station for electric and acoustic performance.

Having passed the tests successfully, the robot moves the fans to the upgrading station (fig. 7 a + b). Here, the units are given their customised finish. “What this entails is, for example, a guard grille being mounted, or a wall ring, a terminal box or even the direct cable connection.“, says the production manager. Finally, the work-piece tray is removed and the finished fan is parcelled up. At the final fan assembly in Mulfingen, everybody is happy and satisfied with how this processing sequence is organised. In order to increase productivity even further in future, a second robotic system similar to this one will be put into operation there.

Fig. 7 a + b: In the upgrading station, the fans get their customised finish.

Heiko Scheu
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Global voltage fans for virtually all applications

Recent decades have hardly seen any new developments in standard AC fan motors. Because of their design principle, their speed is permanently linked to the power frequency; In addition to low efficiency, they have a relatively short service life. Another disadvantage is the small voltage tolerance – even minor deviations in the power system cause large drops in output or service life. Now, a new concept for AC fans brings a convincing improvement in performance. The latest AC fan generation works without conversion on every supply network, whether 120 V or 230 V, 50 Hz or 60 Hz. High energy efficiency provides a tremendous increase in service life. Maintenance costs decrease rapidly, and the logistics effort for motors with different supply voltages or frequencies is no longer necessary. Old AC fans can be replaced with the new ones without any problems; the dimensions and electrical connections remain the same.

There is never enough space – particularly in control cabinets, machine control systems and, of course, in units with power electronics. These devices are frequently exported and need to work everywhere in the world. Therefore, manufacturers must either use an AC fan designed for the subsequent installation location or use DC fans. However, these fans require power packs that not only hog space, but are also expensive and depend on the line voltage. Frequently, two power packs are required in order to provide the necessary redundancy. To lower the logistics effort while simultaneously offering a compact fan in the AC area with completely new features, ebm-papst, the fan specialist based in St. Georgen, Germany, has developed its ACmaxx series. These fans reflect all of the requirements of state-of-the-art device and systems engineering, providing users with a simple cooling concept.

Energy and service life

To minimise the logistics effort for devices for worldwide use, a fan should cover the widest possible voltage range. In the new generation, we have succeeded for the first time in covering the range from 50/60 Hz and 85 to 265 VAC with a single fan. Voltage fluctuations in the power system are automatically compensated for. By directly connecting the fan to the AC power supply rather than to a power pack, you save both space and money. Because each individual fan is autonomous, cooling redundancy increases in multiple-fan applications with no extra effort.

Because the efficiency is up to 75% higher than conventional AC fan drives, this saves energy. At the same time, however, the high efficiency means only little intrinsic heat dissipation, reducing the thermal load on the fan components. In particular, the bearing lubrication reacts positively to the lower temperature. Thus the ACmaxx fans provide

New applications for AC fans with greatly expanded capabilities:
Global voltage fans for virtually all applications

”AC maxx fans – long-lasting and variable fans which open up many potential savings!“

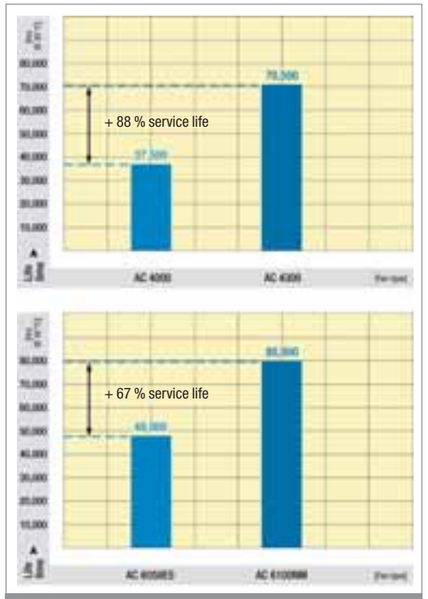

Fig. 1: Double the service life, lower maintenance, greater output

almost twice the service life of AC fans (fig. 1). Increased reliability means longer service intervals. The higher efficiency allows higher air flow and pressure build-up at the same size, because energy that is not heated can be used to increase the air flow (fig. 2). Because the fans' height and width correspond to the old models and their motor depth is only slightly larger, they can be replaced or retrofitted easily.

Additional options for better value creation

In addition to a longer service life, the new fan variants also feature practical additional options. For example, ACmaxx fans have an optional speed signal output with one, two or three pulses per revolution. An alarm output is also available as standard equipment, which can, for example, be output as a static, already evaluated signal to the higher-level control unit. This allows a long-term monitor or feedback of the fan to be quickly implemented for critical operating states. The fan speed can likewise be easily adapted to the current cooling situation, either via a control input in the fan motor or a temperature sensor, which can be external or already integrated into the fan. Furthermore, an additional variant with integrated microprocessor allows a choice of any speed profile. There are even more features that were previously rarely seen in AC technology. Functions such as standby operation, night shutoff and emergency power in case of overload can be implemented with little external effort, and the fans automatically adjust to cooling air requirements.

The new generation of fans is now available in the standard dimensions of 92 x 92 mm, 120 x 120 mm and 172 mm

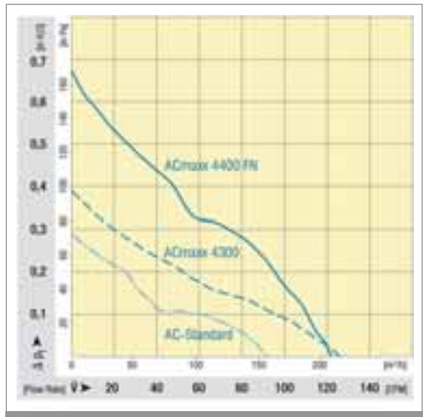

Fig. 2: High energy savings and 40% greater air performance at the same time

Fig. 3 a + b: Reliable cooling for modern high-performance electronics

and in protection classes from IP00 to IP54, upon customer request with moisture-proof winding or with components and stator completely potted in plastic. Thus they are suitable both for difficult applications in control cabinets, machine control systems, compact power electronics modules and use in the latest advanced (inverter) welders (fig. 3). In every case, the additional options save you money – either for the costs of the discrete components previously required or computing capacity for control and monitoring.

The new generation of ACmaxx fans for direct connection to “global voltage” opens up many potential savings. In addition to decreased logistics effort and lower operating costs, particularly important features for advanced systems are reliability and the additional options that are already integrated into the fan. In this way, system manufacturers and users save money in design and operation and value creation increases.

Dr.-Ing. Walter Angelis (middle)
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ebm-papst St. Georgen GmbH & Co. KG

EC-technology for fan and blower drives

In many applications, 3-phase asynchronous motors with squirrel cage rotors are used as drives for fans and blowers. Asynchronous motors are characterised by their simple and robust design and their reliability. Nowadays, however, modern fan and blower drives are expected to also have further characteristics. Among these are economic efficiency and low noise emission, the latter closely connected with a – simple, if possible – closed loop speed control. As asynchronous motors hardly ever meet all these demands, they are increasingly replaced in more and more applications by electronically commutated motors that are actuated by permanent magnets, the so-called EC-motors.

So far, EC-motors have been increasingly used as energy-saving and quiet drive solutions for fans and blowers especially in the lower power range. As they can be well controlled, they are also the preferred choice with "intelligent" or networked fan solutions. For higher performances, the appropriate drive systems were, however, too complex in the past, thus making them too expensive for many applications. Their complicated design, often with external electronics, made these systems also difficult to handle and prone to failures. However, progress in the field of magnetic materials, further developments with electronic components and innovative concepts have brought about a change. ebm-papst Mulfingen, the specialist for motors and fans, for instance, has developed powerful EC-fan drives in the kW-range by now the cost-performance of which leaves nothing to be desired, thus offering interesting applications possibilities. The advantages of EC technology, all based on the functional principle, can therefore be enjoyed and utilised across a wide range of possible applications:

Commutation electronics

In principle, EC motors are synchronous motors actuated by permanent magnets. The magnetic flux in the motor changes in its amplitude and spatial position synchronous to the rotation of the rotor. Other than with the asynchronous motor, the rotor speed does not automatically adjust to the frequency of the supply voltage. Instead, the stator actuation has to be set according to the respective rotor position. Operating an EC motor thus always requires additional electronics,

Highest efficiencies throughout entire speed range:
EC-technology for fan and blower drives

”The efficiencies of EC motors are significantly better than with asynchronous motors“

the commutation electronics, responsible for the current reversal in the windings depending on the rotor position. This is why the motor is like a DC shunt motor as far as its torque-speed characteristic. Establishing the rotor position relies on either integrated rotor position sensors in the motor or on commutation electronics determining rotor position via motor voltage or motor currents and without sensors.

With the EC motor, commutation electronics and motor are a close functional unit. The matching of both components determines operational performance. During the optimisation process, different characteristics can be taken into special account, depending on the application, such as, for instance, efficiency, speed, acoustic performance or costs.

EC-motors are available with internal or external commutation electronics and are designed for operation on all conventional supply systems, from 12-V battery supply up to 480-V 3-phase power supply.

Significantly lower operating costs

With asynchronous motors, the rotor speed adjusts to the rotary field frequency depending on the load and via slip. With this principle, efficiencies between 30 and a maximum of 75 % (in the performance range of up to 1 kW) can be attained, depending on the motor design and number of poles. Higher efficiencies are hard to realise at acceptable costs, especially so as there are not only losses in the stator, but also electric and heat losses in the rotor.

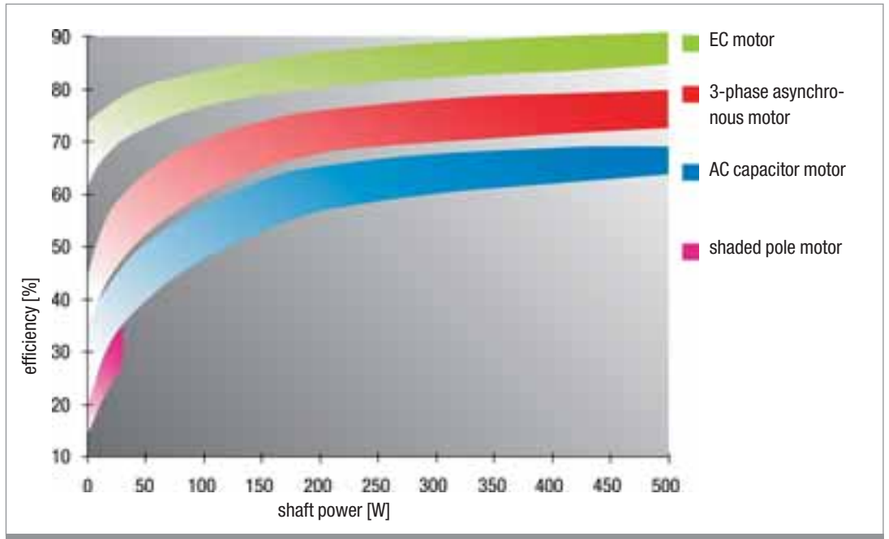


Fig. 1: Efficiencies of different motor types

Things are completely different with an EC motor. Here, idle speed only depends on the voltage applied and the number of windings of the stator winding. Due to this, any desired operational speed can be realised, even above line frequency of, say, 50 Hz or above 3000 rpm. The relationship between speed and torque is mainly linear. There are significantly better efficiencies (fig. 1), and this at smaller size. Depending on the motor design and power output, efficiencies are between 65 and more than 80 %. The electronically commutated and 3-phase fed EC motors (fig. 2) operate at efficiencies of up to 90 %, thus reaching substantially higher efficiencies than the asynchronous motors normally used in this power class. The special concept of the ebm-papst motors makes sure these efficiencies can be reached with cost-effective ferrite magnets.

Fig. 2: EC-motor range: Size 55 motor (left) through to size 150 motor (right)

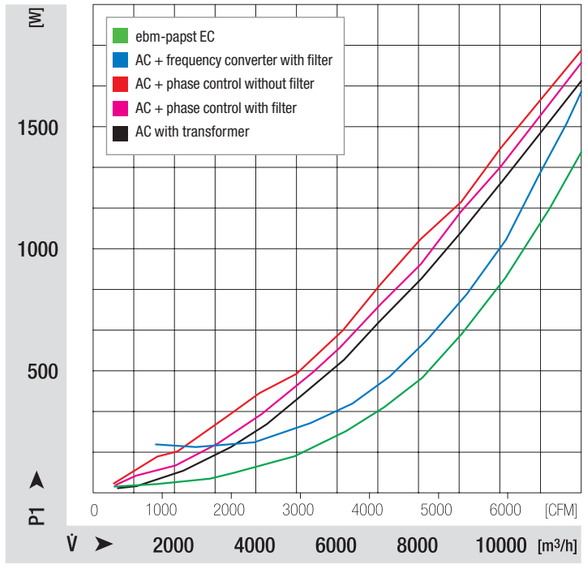


Fig. 3: Power input of open-loop controlled AC-/EC-motors

High efficiency makes for substantially lower energy costs, and this is quickly noticeable in operation and use. Figure 3 shows a comparison of the energy consumption of different closed-loop control systems. Throughout all speed ranges, energy costs of the EC motors are noticeably lower than those of AC motors with either voltage control or frequency inverter. Compared to conventional AC solutions, modern EC technology allows for a reduction in energy consumption by more than a third in many applications.

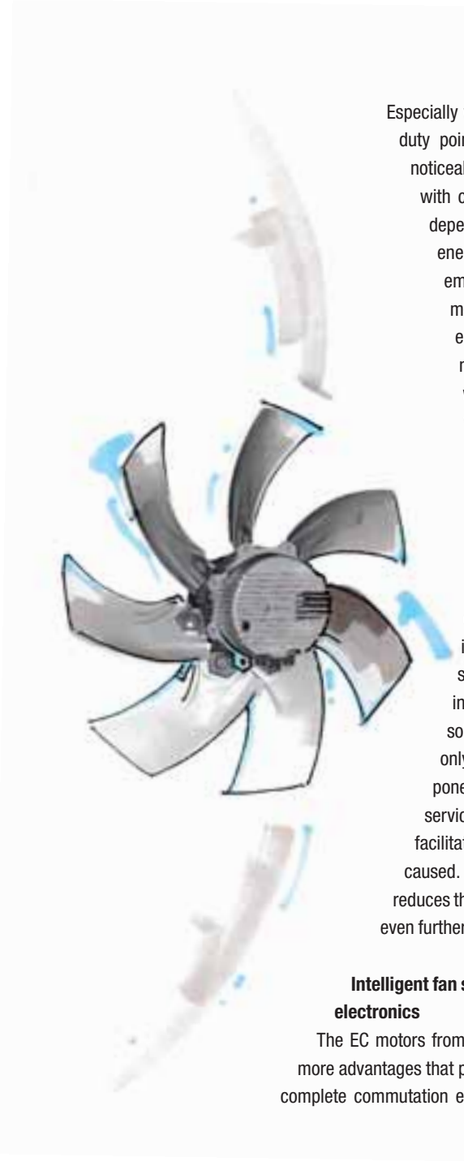
Speed actuation: Energy saving and noise reduction

A decisive factor in reducing energy costs is the speed actuation. Running at constant speed and thus with high noise level, fans and blowers constantly provide air flow actually only needed in extreme cases. A fan is often selected on the basis of worst case scenario, such as maximally possible power loss, very high ambient temperature and unfavourable heat transfer conditions. For many operating stages, however, lower air flow would suffice.

Here, speed-variable fans are a favourable solution. The air volume to be conveyed can then be automatically adjusted.

Highest efficiencies throughout entire speed range:
EC-technology for fan and blower drives

”EC motors from Mulfingen includes the complete commutation electronics!“



Especially with fans, the adjustment of the duty point to actual demand is clearly noticeable, as the power input changes with cubed speed. With temperature-dependent fan control, for instance, energy consumption and noise emission decrease with lower thermal load. This reduction in noise emission is important with a large number of applications, e.g. at work or in residential areas where noise protection regulations apply.

Closed-loop speed control can, of course, also be realised with asynchronous motors. If, for instance, an asynchronous motor designed for direct line operation is combined with an additional speed actuator, the result is an inexpensive and speed-variable solution. At least at first glance. For only rarely are the individual components optimally matched, and so service life is reduced, failures are facilitated and subsequent costs are caused. Moreover, this operation mode reduces the already worse motor efficiency even further.

Intelligent fan systems through integrated electronics

The EC motors from Mulfingen, however, offer even more advantages that pay off in operation: For once, the complete commutation electronics are integrated. Motor speed can be set via externally given actuating signal (e.g. 0...10 V signal). Safety is provided by an integrated over-temperature protection for motor and electronics, over-voltage cut-out, phase failure detection as well as locked-rotor protection and EMC and line filter. If needed, the process control can be integrated in the EC motor, too.

For intelligent fan systems, a number of EC motors can also be networked without any problems (fig. 4). The relevant interfaces such as RS485 and 0...10 V output for master-slave control (group control) are already integrated. The configuration of closed-loop control systems conventionally used on condensers in refrigeration and air-conditioning is thus drastically simplified. Only a comparatively small number of components have to be mounted, which has a favourable effect on costs. Apart from the fans fitted with intelligent motors, only a pressure sensor is required. There is no need for an additional motor protection switch, for instance. Programmable cooling, cooling on demand, and interoperability are further keywords in this context.

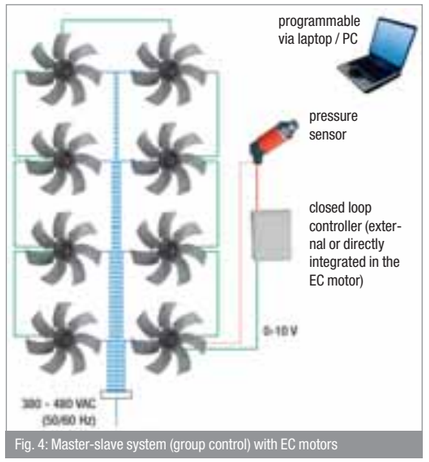


Fig. 4: Master-slave system (group control) with EC motors

The integrated power electronics have been designed for a broad nominal input voltage range. Frequencies may vary between 47 and 63 Hz. Air performance and efficiency remain unchanged. This means that, compared to asynchronous motors, the number of variants is dramatically reduced. As for further processing of the fans, this simplifies logistics, as the same fan is suitable for the most different of specifications. These modern EC motors made by ebm-papst Mulfingen are available in five sizes (size 55, 74, 84, 112 and 150), covering the power range from 30 W to 3 kW.

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No compromise in unit design

Fig. 1: Flow characteristic of a tangential blower. The large cross-section of intake and discharge makes for high permeation with air even at low flow velocity.

With many technical household appliances, tangential blowers are an integral part that nobody would dream of doing away with. They can be found in electric towel driers, premium heaters, storage heaters and sub-floor convectors, as well as in fireplaces, microwave ovens, in jacket cooling of modern electric stoves, and also in overhead projectors. However, the latest types of these units do not provide much installation space for blowers and fans, due to their sophisticated design. New tangential blowers with cylindrical rotor diameters of as small as 30mm cater for this new trend. Compromises in unit design caused by too large blowers and fans are thus definitely a thing of the past.

In household appliances, tangential blowers have been a favourite choice due to their elongated and flat design. At first glance, they appear to be centrifugal fans stretched in one direction, yet their functional principle is a totally different one: First, the air is sucked in across a large surface and tangentially to the rotary axis through the cylindrical rotor, is then diverted by 90°, is then taken up tangentially to the rotary axis inside the impeller, diverted again and then conveyed into the housing (fig. 1). Subsequently, the air is usually discharged via a slot corresponding to the length of the impeller. The large cross-section of intake and discharge makes for high permeation with air at very low flow rates already. Great thrust and the very low noise levels are further characteristics making tangential blowers so absolutely suitable for use in household appliances. However, designers and developers prefer fans and blowers that, for obvious reasons, do not take up a lot of installation space. After all, nobody wants to design a heating fan, an electric towel drier or an overhead projector "around and about a fan".

Cylindrical aluminium rotors with only 30mm in diameter

Consequently, the motor and fan specialist ebm-papst Landshut has come up with a new development in tangential blowers: Their QL3 line (fig. 2, see page 26). These blowers have been specifically designed for applications in the field of household appliances where limited installation space is a crucial factor. With cylindrical rotor diameters of only 30mm, these blowers can be fitted in without any problems, even if installation space is very restricted. Depending on the specifications of the particular application, the motor can also be mounted to the blower with either horizontal or vertical terminal, to the left

Slim tangential blowers for household appliances:
No compromise in unit design

”Tangential blowers – simplified production turning them into inexpensive solution“

Fig. 2: Quiet, compact and easy to install: new tangential blowers with diameters of only 30 mm.

or to the right as needed, with twin blowers even right in the middle of the cylindrical rotor. The latter position reduces cost and installation time, as one unit replaces two blowers. Typical applications for such twin blowers (fig. 3), where one joint motor drives two cylindrical rotors, are for instance fire places, sub-floor convectors or jacket cooling of modern electric stoves.

The housings of the new tangential blowers are made of humidity-proof extruded aluminium sheath. Compared to sheet metals conventionally used, this design offers a number of benefits: Manufacturing is simplified, which translates into lower costs for the user – always a positive thing! The profiles can also be easily cut to length. The end parts with the bearing (fig. 4) respectively the motors can be easily attached and fixed regardless of the length. This new design reduced the number of tools needed in production substantially.

Thus, the tangential blowers are available in a variety of lengths. Serially, there are designs with 150 mm, 200 mm, 250 mm, 300 mm or 350 mm long cylindrical rotors. In principle, however, other customised dimensions can be realised. The extruded aluminium sheaths are also comparatively lightweight and humidity-proof.

Precisely matched aerodynamic device and drive motor

The tangential blowers are driven by proven and also compactly built shaded pole motors taken from the EM21 line (fig. 5) of the ebm-papst drive range. Shaded pole motors are not only less expensive than three-phase motors or capacitor motors, their comparatively simple design makes them also more reliable and robust. They only have one winding and no expensive, failure-prone capacitor. As they can be directly operated on AC voltage, they are well suited for use in household appliances.

Fig. 3: The motor can be mounted horizontally or vertically on the aerodynamic device, to the right or the left, or right in the middle of the cylindrical rotor as shown here with the twin blower.

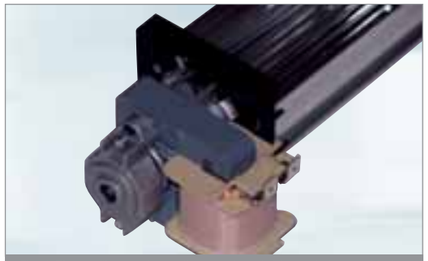

Fig. 4: The profiles can be easily cut to length. The end pieces with the bearing – or the motors on the other side – can be mounted with the same tools regardless of the length.

The shaded pole motors are available in different performance classes with lamination widths of 8 mm, 12 mm, 18 mm or 24 mm and with different numbers of windings. This ensures that even with small or medium quantities, cost-effective and still customized solutions can be realised for the most varied of applications. The permissible ambient temperatures are between 0 and + 60 °C, and with strong humidity, motor designs with encapsulated coil can be used.

The characteristics of the tangential blowers are exactly set to the required air performance. This was in no small way due to the long years of experience and the expertise in fans and blowers the manufacturer could rely on when designing the aerodynamic device. Curvature, length and angle of the cylindrical rotor blades are exactly matched to the respective speed range of the new tangential blowers. The user benefits from this, as the good electrical and mechanical adaptation of the components makes the tangential blowers not only extremely quiet, but also durable. And even with electric units meant for global export, these benefits can be made use of: The tangential blowers of this new line operate on supply voltages of 230 V, 220 V or 120 V (at 60 Hz respectively 50 Hz).

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External rotor motors ideal for laser scanner drives

Fig. 1: Scanner used to safeguard industrial trucks

Laser scanners are indispensable for modern plant engineering, identification of persons and objects, and security technology. They use a laser beam and optics to scan the surrounding area. To cover a wide area with one beam, the reflection mirror or prism must rotate. Therefore, for accurate results, the drive motor needs to work at a high and very constant speed. Modern, electronically commutated external rotor motors are an ideal match for the stringent requirements for minimum speed droop and a durable bearing system. This guarantees a high scanner resolution that remains the same over the long term.

Optical, touch-free object detection is where laser scanners excel. The scanner experts at SICK offer a wide range of different devices for these applications. Whether used for museum security, access control or barrier-free protection of machines and system parts, laser scanners offer a great variety of possibilities. Scanners are also in demand in mobile applications, such as safeguarding industrial trucks or identifying vehicles on expressways for toll collection purposes (fig. 1). To reliably meet the high standard required for the integrated optics' drive, the scanner specialist is cooperating with motor manufacturer ebm-papst of St. Georgen, Germany. In a system partnership, they have developed the optimal drive for a new generation of scanners.

High-resolution and durable

The principle of the laser scanner is based on a highly focused laser beam that covers a wide, fan-shaped angle range. To attain high resolution and detect objects at high speeds, the transceiving optics must rotate quickly; The usual speeds are from 2000 to 4000 rpm. Equally important for this purpose is the synchronous running of the optics.

Angular errors due to excessive play of the bearing system are unacceptable, as they change the position of the reflected beam on the evaluation sensor in an unpredictable manner. A bearing system with high-precision ball bearings is the basic requirement for good concentricity over the long operating time. Only in this way can the reflected laser beam render a realistic image of the surrounding area. Another important point is the long-term stability and service life of the drive with minimum running noise. Consistently good measurement results must be provided over a long period of

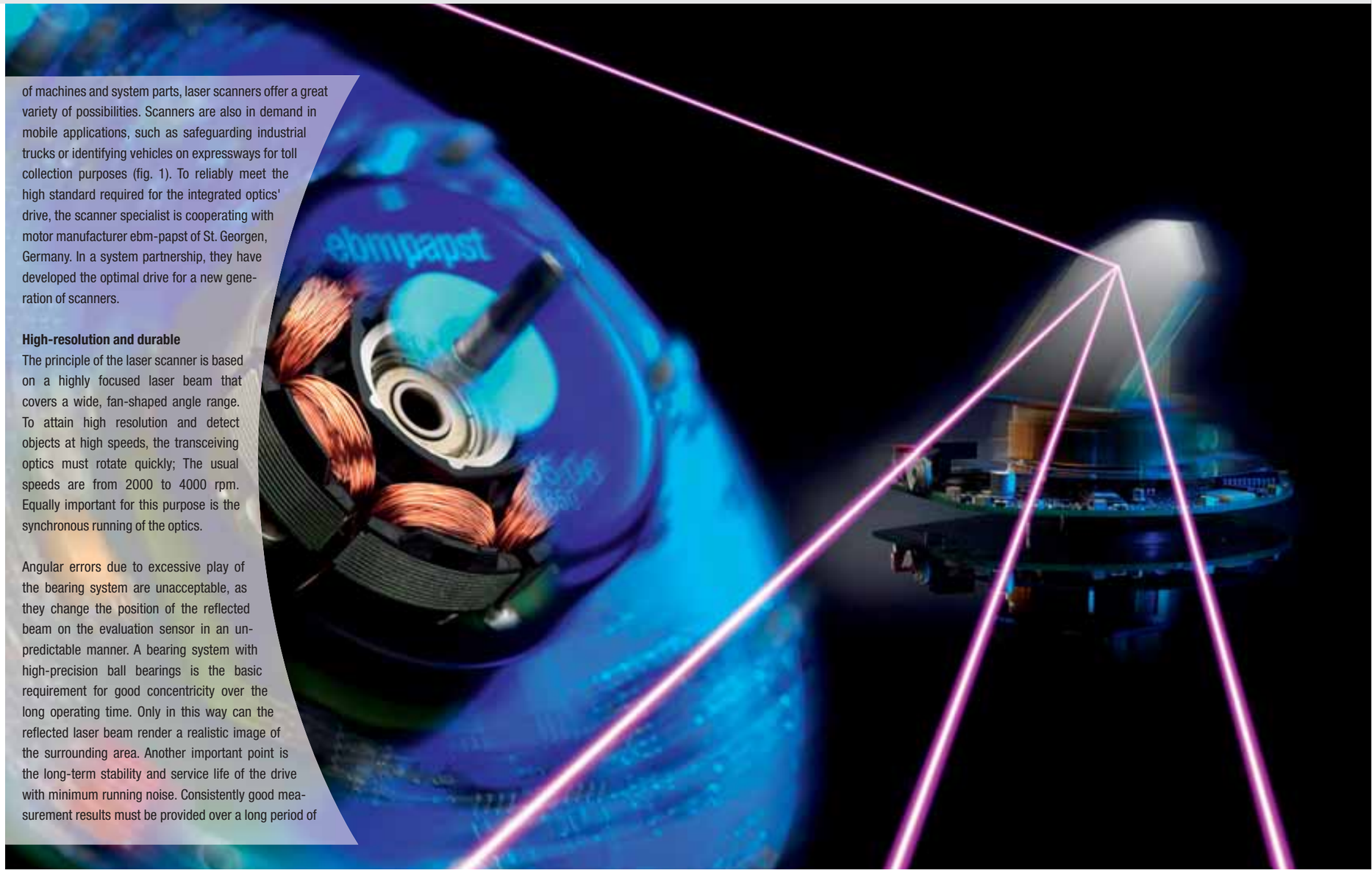

Fig. 2: Drive motor with electronic circuit board – Components for additional options can be integrated easily.

operation. No less important is the need for a compact motor design. For example, the motor electronics have to assume additional functions in addition to the synchronous speed control of the drive (fig. 2). By entering into a system partnership initially when beginning development of the compact drive motor, the circuit board could be equipped with additional components, such as a function for measuring the contamination level of the optics and an interface for measuring the current speed.

Additional applications

Modern scanners are capable of combining personal safety and the detection of shapes in the surrounding area. Installed at a suitable location, a scanner safeguards a system radially, at a distance of up to seven meters. In this manner, scanners certified for personal safety replace mechanical barriers, which can get in the way. In the mobile area, they are the first choice for industrial trucks to provide flexible, real-time detection of travel paths and simultaneously watch out for obstacles that suddenly arise. Of course, they can also be used with reflector marks to support navigation (at ranges up to 30 m) and in all types of applications with moving machine parts, as is common in logistics and materials handling. Security technology also makes more frequent use of this modern technology to monitor objects and the areas surrounding them simultaneously. High resolution, long service life and fast activation are the keys to success in this market segment (fig. 3).

Adaptable EC external rotor motor

External open and closed-loop control devices for drives, along with the necessary cable connections, are difficult to install and raise the costs. An easy-to-use motor is one that can be installed and connected to the power supply and data and control cables easily, and is then ready to go. From that point on, the drive needs to run without requiring any more attention from the user. Therefore, an electronically commutated external rotor motor of the Variodrive Compact series was selected. An intelligent RISC controller ensures a maximum range of functionality for the motor control system. All electronics are compactly integrated into the motor housing and surrounding board. An additional slotted disk with high resolution guarantees the high synchronous running quality required. MOSFET transistors switch the power of the motor with minimum switch-on resistance and power loss. Installed on a multilayer board with SMD equipment, the result is a compact, multitalented "drive brain." EMC protection is ensured by optimized strip conductor placement and a ground plane over the entire PCB surface. This kind of localised data processing with short lines prevents many of the EMC problems of conventional, externally controlled drives from ever occurring.

An ideal fit

By definition, the rotor in external rotor motors is located externally, above the exciting winding. The advantage of

Fig. 3: Today, certified stationary and mobile safeguarding of systems and components is no longer a problem.

Smooth running, long service life and additional integrated options:
External rotor motors ideal for laser scanner drives

”Users obtain an optimum cost-performance ratio!“

Fig. 4: Now, even complex attachments and drive loads can reliably be kept at a constant speed.

this arrangement is the large amount of installation space for the magnet material, which is securely fastened in the bell-shaped rotor even at the highest speeds. This results in a high torque and simultaneously provides very good synchronous running due to the high centrifugal mass. The rotor, which is open and accessible, is ideally suited for carrying attachments such as prisms or mirrors (fig. 4). By means of precision balancing, even highly asymmetrical attachments can be brought to minimum imbalance. The mechanics are another area in which the designs – which are specially adapted to customer requirements – differ considerably from the standard. For example, motors in the scanners have to work in a very wide range of temperatures, from - 30 ° to + 50 °C. This must be taken into account in the bearing and permanent lubrication.

In museum security and similar applications, a very low, practically inaudible running noise is an absolute must, as is highly constant speed. An additional factor is the strain on the bearings from shock and vibration in mobile applications. In these situations, too, the scanner must work reliably. The result of these requirements is a two-quadrant-controlled EC motor with a diameter of 44 mm and an overall height of 26 mm. It can accelerate the attached optics to a speed of 2000 rpm.

Off-the-shelf motors generally require willingness to compromise in many details. Furthermore, it often takes a great deal of design effort for users to adapt these drives to the application. Engaging in system partnership from the very beginning when developing new products guarantees that the drive will be an ideal match for the specific application. Special requests with regard to motor output data, service life or additional options for the electronics then can generally be implemented in a cost-effective manner. In this way, users obtain an optimum price-performance ratio without having to familiarise themselves with the intricacies of drive engineering. This substantially reduces the time to market, a cost and time advantage that is otherwise difficult to achieve.

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