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‘I calculated in my mind how long we would survive’

In Star City near Moscow fighter pilots and scientists become astronauts and cosmonauts. And they become heroes. They may increasingly reject the role, but it is dictated by place and tradition. A visit to Alexander Gerst and his Russian colleagues.

By Eva Wolfangel

1. Emergency in the “Soyuz” capsule

Just short of the safety of the station, the system fails. The International Space Station, ISS, is only a short sprint away. On Earth, Alexander Gerst would cover the distance in a few seconds. But here on Soyuz, just a few cubic metres of air and a thin layer of aluminium separate him from the hostile environment of space. Now, nothing must be allowed to go wrong. So far, the flight from Earth to the space station has been unproblematic, but now, on the last few difficult metres, the automatic system lets them down: Gerst and his Russian colleague, Anton Shkaplerov. The two astronauts engage another system: the one in their heads. They have practised this situation innumerable times so that, if it happens, they respond like robots. They control the spacecraft by hand. Gerst uses field glasses to direct the laser measuring device at a fixed point on the space station. ‘200 metres,’ he says. Shkaplerov responds: ‘And now?’ ‘200 metres.’ ‘Now?’ ‘200 metres.’ And so it continues for an interminable three minutes. Shkaplerov controls the spacecraft, Gerst does the measuring. Nothing moves. Then: ‘195 metres.’ 190. 190. 190. ‘Repeat every 20 seconds,’ Shkaplerov orders. Gerst does. For minutes on end. 180, 180. 180. 175. The cosmonaut flies intentionally slowly. At such close proximity, the danger of ramming the station is enormous. With life-threatening consequences both for the astronauts in the capsule and the crew on board the ISS:

175.

174.

170.

Then a voice off: ‘Okay, next scenario.’ The Soyuz capsule is not flying through space but standing in a huge hangar near Moscow. Next to it are three tables with monitors being studied by the three men who thought up the emergency: trainers at the Russian Space Agency Roscosmos. The emergency felt real but is only simulated. We are not in space – we are in Star City.

Here in Star City is where all the current western manned space missions begin. And in contrast to the journey from Earth to the ISS that only takes six hours, this preparation lasts years. During this time, people change. Pilots, military pilots and scientists become astronauts and cosmonauts. And they become heroes – even before they have left the ground. At least in the eyes of their milieu. Here, they are exclusively referred to as "heroes" – after all, they expose themselves to great danger, the argument runs. And this danger is omnipresent. Every emergency that could occur in space, every eventuality, is played through here. Countless times.

All that practice! 'Some astronauts call this place the "space camp,"' says Alexander Gerst, grinning. He leans against a wall with countless switches and buttons in the Russian ISS module. Or, to be precise, in its twin in Star City. The models are as close to the original as possible so that the astronauts feel at home when they really start out. 'You sometimes forget that you'll soon have a real rocket carrying 300 tonnes of fuel beneath you.' All of a sudden, the game gets serious. This rocket can be dangerous, not only when the automatic system fails. Most accidents occur during take-off and on the return to Earth: when re-entering the atmosphere.

Isn't he scared? Alexander Gerst looks as though he's fed up with hearing this question yet again. 'Lots of people ask me that, but no, during my last flight I had a healthy respect for my surroundings, but I wasn't scared.' Alright, well, perhaps if he wasn't prepared. He has a very rational explanation for fear: it arises when you are unprepared for a situation and lose control of it. 'We run through the worst cases umpteen to hundreds of times to minimise the probability of losing control.'

For that, he spends a lot of time in this closed-off little town near Moscow that started up in the 1960s when the first cosmonauts were trained here. If you want to get in outside the official guided tours for tourists, you need powerful supporters, an official invitation from Roscosmos or relations living locally. It used to be a restricted military area and, to this day, the town with its 6,000 inhabitants is closed to the public. The population largely consists of former and active cosmonauts with their families and relations together with the staff at the training centre.

2. Alone amongst heroes

You soon notice that the buildings are showing their age. Star City was built at the beginning of the Sixties. Yuri Gagarin was not only the first man in space, he was also one of the first inhabitants of the secret city and the first cosmonaut to be trained in the town's training centre that is now named after him. And he is still the hero of this place today. His statue rises up into the grey skies far above the heads of the people walking the same way he used to. And this is the way his statue seems to be heading, too: from the apartment blocks to the astronauts' training centre. 'It's as though he were still with us,’ says one passer-by, wistfully. The stone Gagarin is very upright, his left arm hidden behind his body, a flower in his hand. Legend has it that the flower was meant for his wife who still lives in the flat they used to share. Looking out of her window she can see the back of her over-dimensional husband every day.

In every building, the visitor is greeted by a Gagarin statue, a portrait or a mosaic. The hero hovers over everything, including Alexander Gerst as he hurries past Gagarin’s plane in front of the training centre enroute from Soyuz training to Russian lessons. ‘You can feel the spirit of Russian space travel here,” he gushes. All these statues, but also the old “Mir” modules and “Buran” orbital glider used in training, are an inspiration. He enthuses about the fascinating training setting. But life in Star City does have its downsides: every astronaut has to learn Russian which, Gerst admits, is arduous.

A short while later, he is sprawling in a chair like a tired schoolboy, with an iPad instead of an exercise book, opposite him the Russian teacher with a long pointer in her hand standing in front of a screen, very upright, with a rather stern expression. She checks his knowledge of the Soyuz’s new automatic docking system with which he will go into space in 2018. She discusses the correct terms for oxygen cartridges and commands, and, above all, the right grammatical cases of which there are six in Russian instead of the four in German. The language is difficult and here, too, Gerst has to know the right words for all eventualities, be able to decline all the emergencies in his sleep. Because the official language in the Soyuz capsule is Russian, without exception.

This has been going on for years. Every week, Russian lessons, sport at least every second day, simulation training in the Soyuz capsule three times a week, drills in the various ISS modules. Preparation for a space flight takes four years. ‘One year is spent training just for the six hours on the spaceship,’ says Gerst. Then there is emergency training for all kinds of incidents on the space station itself – from dental operations to dealing with fire, pressure loss or failure of the life-support systems. Gerst commutes between Moscow, Houston and Cologne. He has long since acquired his basic wardrobe in triplicate and is at home everywhere and nowhere. ‘I have friends everywhere,’ he says. The astronaut community is small. In the evenings he meets up with American colleagues for a beer or shares a sauna with Russian veterans. Some of the first-generation cosmonauts still live in Star City.

Before going into quarantine prior to setting off for Baikonur, there is a traditional farewell breakfast in Star City. Before Gerst’s first flight in May 2014, Alexey Leonov, one of Gagarin’s former colleagues, took the young astronaut to one side and told him what to do if he felt nauseous during take-off. Gerst is only too familiar with the story of how Leonov, during the first ever extra-vehicular activity in the history of humanity back in 1963, nearly didn’t get back into his spaceship because his space suit had inflated in space. It was only thanks to an idea that contradicted all the rules that he was able to save his own life: he reduced the pressure in his space suit, endangering his life at the same time. Luckily, he didn't go into details at this breakfast; the point about nausea had already sufficed to make Gerst feel twitchy.

Whatever, at the end of his stint in Star City, Gerst knows precisely what can happen and what he's doing. He is familiar with every single one of the countless buttons and switches in the Soyuz spaceship. He knows whole chunks of the manual off by heart, even though it is as thick as a church Bible and twice as big, but the crew still conscientiously studies it page by page at every training session and on every genuine flight. It describes every single manual action. When everything goes well, the crew is mainly responsible for monitoring this system. That's the hardest thing, Gerst admits, the enormous concentration of permanently reporting to ground control and still reacting immediately if something unexpected happens. 'We only have a few seconds to notice and respond.'

A problem with the launcher, a hole in the fuel tank, a leak in the oxygen supply: for most conceivable errors there is a plan B, a tiny change of routine. 'It gets difficult when several problems occur at once," Gerst explains – a situation he knows only too well from his training. Then he has to keep track of exactly when he changed from Routine A to Routine B and how that pans out two hours later if a part of the journey follows Routine C and, at the end, the crew revert to Routine A once again – which, however, has its gaps because of the previous change in Routine. And then there are all these buttons that he must on no account press at the wrong time. For example, the one that separates the space capsule from the rocket. 'You can cause a disaster with just one button,' he says, 'on the spaceship you can make a lot of mistakes when you're overworked.'

3. Switching off the fear, switching on the mind

Fear of the wrong button is something Alexander Lazutkin knows all about. He flew to the Mir Space Station in 1997. Now 59, the mechanical engineer only spent a total of six months of his life in space – and that was 20 years ago. None the less, that is what defines his life. He will always be a former cosmonaut and a "Hero of the Russian Federation". Even though he doesn't consider himself very heroic, not today, let alone at the beginning of his mission, as he unashamedly admits: 'I did feel afraid when I reached the space station. I was scared of pushing the wrong button, scared of breaking something.'

And then one of the worst possible accidents that can happen in space did happen, in an enclosed capsule where no air exchange is possible: Mir caught fire, just a few days after Lazutkin arrived. The crew were sitting together celebrating, as far as celebrations were possible amongst all the cables and devices. It was 23 February, "Defender of the Fatherland Day" in Russia, and the cosmonauts had even brought caviar with them in honour of the occasion. Lazutkin wanted to increase the oxygen ration because with six astronauts on board the Mir was full – Lazutkin's crew had just arrived, the old crew hadn't yet started back to Earth. He was the first to discover the fire that was spreading near the oxygen generator.

He tries to remove the oxygen tank that is already feeding the fire with oxygen, but the fire is too big. 'Then the fire alarm went off, the others appeared, and I saw the horror in their eyes.' The astronauts try to quell the fire with all the available fire extinguishers, but it keeps spreading. Thick smoke everywhere, the astronauts can't see further than the length of their own arms. The smoke is too thick to breathe, they pull on oxygen masks. Lazutkin starts to prepare for evacuation but the spaceship the crew want to use to return to Earth is full of smoke, as well. The path to the other one is barred by the fire. 'I was suddenly very scared,' Lazutkin admits. 'After all, there were no windows and no fire brigade. I thought, "If we fly off now with all that smoke, we'll all die."'

So, he turns back and continues to fight the fire which, finally, miraculously, does get smaller. When the astronauts can see again, the main thing they see is soot. Many parts of the station are blackened, cables charred, but all the important systems are still functioning. It takes days though before the filters can remove all the smoke from the air. 'It would've been a shame to abandon the station if we'd left,' says Lazutkin today, soberly. And it did have a good side: Lazutkin had overcome his fear. 'I thought, well, if we can cope with fire, we can handle anything.'

4. There is no such thing as complete safety

Alexander Gerst also experienced a fire on his first stint on the ISS. A water heater in the Russian part of the station burnt out. The crew only noticed little clouds of smoke around the device when the fire alarm went off. Gerst admits that it initially sent a shock wave through him. 'In the first few minutes, you just don't know what's going on. Fire in an enclosed space is a very serious thing.' When he reached the point in question, the smoke was already under control, the fire had not broken out properly. 'We reacted very well,' says Gerst. Exactly according to plan.

Whilst the fire in the Nineties could have led to a life-threatening situation, by 2014, this kind of event is hardly worth mentioning. The perpetual repetition of eventualities, the many back-up plans, modern technology: Is today's space travel less dangerous than it used to be? Do perhaps today's young astronauts reject the idea of being heroes simply because space travel has become far less threatening? 'Gagarin and Co. set off on an almost untested rocket,' says Gerst. 'Today, we have more safety systems, but there are more places where you can trip up.' People shouldn't imagine space travel is safe. But he is philosophical: You have to assess the risks very precisely and be clear about the residual risk. Then decide whether you want to expose yourself to it. 'We are discoverers, space travel is not an end in itself. And for that, it's worth taking a certain amount of risk.'

Lazutkin says almost exactly the same. He sees himself as a discoverer, too: To see the world from the outside and tell people about it, that's worthwhile. 'The job has become more routine,' he adds, 'but when it comes to actual safely, it's hardly got any safer at all.'

The new confidence he feels after the 1997 fire is soon put to the test once more: in a collision only four months later, the unmanned space freighter "Progress M 34" rips a hole in a Mir module. Pressure in the station immediately drops. If the crew doesn't fill the hole up quickly, they will all suffocate. Lazutkin has already felt the loss of pressure when the system reports it. And, again, that switch in Lazutkin's brain engages: 'At that moment, my head was only there to see what my hands were doing.'

The astronauts try to separate the affected part of the station from the rest. This means closing a hatch, but it is blocked by multiple cables. Lazutkin conscientiously reads the instructions: In this event, the cables are to be cut with a certain knife. The place where this knife is to be found is also described. Lazutkin goes looking for it, but there it isn't. He finds a smaller knife, takes it with him, but fails: the cables are too thick. Finally, he unplugs every individual cable by hand. The clock is ticking. All the while, the commander is taking the readings and Lazutkin hears how the pressure in the cabin is continually falling and counts the minutes. 'I calculated in my mind how much time we still had, how long we would survive.' He finds a key, but it doesn't fit. He flies through the station again and finally finds the right one. The whole procedure takes 15 minutes instead of the three given in the instructions. Lazutkin holds the door shut like one possessed, he can't let go even when his commander tells him the pressure is back to normal. 'I hear what he says and understand that the pressure is no longer falling, but I can't leave the door.' Only on the third announcement does he drag himself away from the door.

The crew had been saved. They subsequently survive two power cuts during which they have to withdraw to the spaceship. At which point, the station begins to revolve around itself. Lazutkin and his colleagues hold it on course by counteracting it with the spacecraft from the outside. 'Of course, the life-support systems had switched off, too,' Lazutkin casually remarks. Of course. After the fire, almost nothing could frighten him. And after the experience of being completely alone in space. And that is the crucial difference to training on Earth. 'There the trainers were always around and told us whether we were doing things right or wrong,' he says, 'but up at the station I realised nobody could help me.'

All this training and state-of-the-art technology is intended to ensure that nobody dies. 'But sometimes somebody does die.' Like the seven astronauts who lost their lives in explosions on the US space shuttles "Challenger" and "Columbia" in 1986 and 2003 respectively, like the three cosmonauts who suffocated in a "Soyuz" spacecraft in 1971, or in 1967 during the first manned Soyuz mission when the parachute failed to open during landing. Lazutkin can quote all the space disasters with dates and casualties from memory. ‘You have these thoughts before the start, but not at the front of your mind.’

5. Hard ride through the atmosphere

Alexander Lazutkin is sad when he has to return to Earth after six months. Right up to his last day on Mir, 14 August 1997, he hopes for a miracle, that they will ask him to stay on longer after all. ‘I had just got used to it and experienced the station as a living being, I finally knew where everything was.’ In the end, all that is left is the hard ride back to Earth. With a heavy heart he enters the spaceship, not yet knowing that he will never fly again. When the spaceship enters the Earth’s atmosphere some hours later at a speed of several thousand kilometres per hour – one of the riskiest moments of a mission – Lazutkin feels the enormous force of the thick layers of air acting as a brake. They push him back into his seat and take his breath away. ‘It was an unusual feeling, but I wasn’t afraid.’ Then he floats down the last few metres to Earth by parachute. ‘When I was standing back on the Earth again, I suddenly had the feeling that I wasn’t threatened by a drop in pressure anymore. It was the realisation that I hadn’t felt afraid in my mind, but I had in my soul. I felt that the inner tension had gone.’

These last few metres are now facing Alexander Gerst. Huddled together like an embryo in the womb he lies in the Soyuz landing capsule, Anton Shkaplerov next to him. Four hours ago, the spaceship undocked from the International Space Station, the astronauts wear spacesuits with an integrated air supply, they can barely move. They have velcroed their notebooks to their knees, Shkaplerov holds a long stick he uses to press the buttons he can’t reach in the confined space. Both concentrate on their screens that are divided up into lots of little squares, the retro graphics reminiscent of the game Minesweeper.

The spaceship has one hole in the fuel tank and one in the oxygen tank, a pressure sensor has activated in error and reduced the pressure to practically nothing – this had almost given rise to a deadly vacuum and there had been a number of other problems, too. The astronauts had to resort to various back-up strategies to survive the flight up to this point – and now, at the end, they need to keep track of everything in order to push the right buttons at the right time. If they are out by just a few seconds, instead of landing as planned in the steppes of Kazakhstan where rescue teams are awaiting them, they might end up in the Pacific or Aleppo – places one would certainly prefer not to land.

Soyuz enters the atmosphere where it divides into three parts, the instrument module flies off – only the landing capsule with its heat shield survives the blast of several thousand degrees Celsius of plasma that are produced by the friction with the air layers. Gerst and Shkaplerov have to consider up to 20 different parameters concurrently and decide how they are going to react within seconds. The spacecraft is moving at eight kilometres per second – if you wait for ten seconds, you are 80 kilometres further on. But not even once do they hesitate too long. They float the last few metres down to Earth by parachute, lie there in their capsule, hands folded, eyes almost shut – it almost looks as though they are asleep. The Earth has reclaimed them.

Whilst Alexander Gerst, sweat-soaked, is climbing out of the capsule in the knowledge that he has come a little bit nearer to his next flight and is equipped to deal with many other emergencies, Alexander Lazutkin is standing next to the "Exhibition of the Achievements of the People's Economy" in Moscow, looking a bit lost. He is surrounded by the narrow landing capsules used by the first generation of cosmonauts, historical and contemporary space suits, reproductions of parts of the Mir Space Station. 'I always wanted to fly to the moon,' he says and looks somewhat wistfully at the moon rover that resembles a four-legged robot with a huge spherical head. 'But that wasn't to be.' When the Americans won the race to land on the moon in 1969, the Soviet Union's top-secret moon programme was discontinued.

What has remained for Alexander Lazutkin? The honour of being a "Hero of the Russian Federation." But this gets on his nerves most of the time, especially how people treat heroes. He describes trying to make an appointment with a civil servant and being ignored by his secretary. Only when she discovers that he is a "Hero" does she ask him to sit down and offer him a cup of coffee. 'How can it be that, as a person, I'm only worth a kick in the pants, but as a hero, I have the right to a cup of coffee?' he asks, sounding bitter. 'And what is a hero anyway? I was only doing my job.'

Die ZEIT, 06/01/2017

Who was that?

Whenever you make a bank transfer via the Internet, you leave unique tracks. Using such biometric footprints, a discreet company identifies millions of users on behalf of banks. The users don't know anything about it.

By Eva Wolfangel

Natia Golan watches the hacker with the utmost calmness. The hacker has taken control of the online account of an unsuspecting British bank client making a transfer. As soon as the client is done, the hacker reaches out from a distance, logs in with the client's data and pretends to act from her computer. The password is correct. Even the amount the hacker is transferring, just over a million pounds, is not uncommon for the above-average wealthy clients of this bank. And yet something is different.

It is the small arcs in which the hacker moves the mouse pointer over the screen. When he moves from one position of the transfer form to the next, in order to enter the sum in one field and the account number in the next field, the pointer stops briefly several times. "He’s using the touchpad," recognizes Natia Golan. She does not know where the hacker is. She is watching his movements on a computer in Tel Aviv. And her acumen is helped by software: Small red circles mark the particular movement pattern of the hacker on Golan's screen. For comparison, the typical movements of the client, the victim, are displayed in blue.

“We caught him," Golan triumphs. In fact the hacker was not caught, but he was logged out of the account. “We saved the bank more than a million pounds - and it was so easy!” The enthusiasm is part of the job; Golan is Director of Product Management at Israeli startup Biocatch. Discretion is at least as important for this job; at which bank the betrayed client has her account, she will not reveal. And actually Golan shows such examples only to potential new costumers: other banks that want to dismiss hackers with equal ease. The visit to Tel Aviv had a long lead time, because this is a technique developed for secrecy.

So the client does not know that her account was the target of an attack. And neither does she know that her bank pays a company from Israel to make a profile of her. It says how long her forearm is and how flexible her hand is; whether she has a slight tremor; the breadth of her thumb and the size of the smartphone she uses to visit her bank's website; whether she is skillful in handling the phone with one hand; whether she is left-handed; how strong the muscles of her forearm are and how fast her brain reacts to unexpected challenges. "We calculate all that from the movements and activities," explains Golan. In other words, just by visiting the online banking site, the user has generated the data for the profile she did not suspect. A profile that is very likely to be different from any other person in the world.

The discreet company from Tel Aviv is the pioneer of a new technique and its name symbolizes it: Biocatch is a compound word derived from biometrics (from the Greek bíon and métron, for life and measure) and catch. Anyone who is not who he claims to be should be caught - on the basis of individual characteristics of the body and behavior. On the one hand, this promises the ultimate password. On the other, it raises questions about privacy.

Six hundreds factors have been identified by the Israeli developers, and can be remotely calculated from how a person operates an online banking website. "Twenty to thirty of them define you unequivocally and uniquely," says Avi Turgemann, founder of Biocatch. For the 37-year-old physicist, the British client is simply a distinctive number; one of 40 million active online banking clients around the world on whom his company keeps an eye as soon as they log into their bank accounts. The slim man with trendy glasses with wide temples and short beard stubbles looks like many young creatives in Tel Aviv. But his idea has made him the boss of a growing company with branches in Boston, London and New York. It is obvious, he says: "The only effective solution against attacks in the internet is if one continuously authenticates the clients."

Authentication today is usually done by passwords. And everyone knows the recurring advice: You should choose secure passwords consisting of numbers, letters and special characters, not of whole words... But all good passwords have one thing in common: users cannot remember them; certainly not a different one for each service. That's why most people use simple passwords for all their logins. Stealing these is the simplest exercise for hackers. "A password might protect your account from your family," says Turgemann,"but not from professional attackers." He sits in the kitchen of the company headquarters with a large cup of coffee in his hand. On the wall there are colorful sayings such as "Eat, relax, play", on the table dozens of muesli dispensers with all sorts of cereals. Turgeman goes ahead into the meeting room, where a note is hanging on the door, just like the ones on the toilet door and the fridge: "Don’t forget to lock your screen." Distrust is in their corporate DNA.

The founder explains that his system is constantly learning: whenever the user is online, it analyzes his movements and interactions. Does he check his account balance first or does he make a bank transfer first? Is his right thumb limited in movement? “After about 20 minutes of learning, we can create a fairly accurate profile,” says Turgeman. Next time, 40 seconds of activity will suffice to distinguish between the account holder and an attacker. The probability of thieves being detected by this method correlates with the number of legitimate users who are mistakenly rejected. The banks must therefore decide individually, Turgeman explains, whether to accept a higher rate of rejected clients at a higher level of security, or to allow their users as much comfort as possible and accept that some thieves will not be discovered. He points to a poster on the wall that depicts the connection in several graphics. He is more of a scientist than a salesman; it seems important to him to explain this very precisel,, along with the fact that the accuracy of his system cannot be expressed in single numbers. Finally, he indicates a point where two lines of a chart meet: "That's a typical combination": 91 percent of all attackers are detected, while 0.5 percent of all legitimate bank clients are mistakenly rejected. "Most banks can live with that".

Behind such percentages is a large number of real people. With the Royal Bank of Scotland, Europe's third-largest bank is one of Biocatch's customers. No other bank has allowed the company to advertise its name. But Turgeman claims that other customers are three of the five largest banks in the UK and the largest in Spain, Italy, Brazil and North America. Not all of them tell the Biocatch boss how many fraud attempts his system is thwarting, but he assumes thousands of cases every week. His algorithms currently monitor two billion transactions per month, says Turgemann, which is around 66 million a day.

The founder of the company had his favorite trick patented. Turgeman speaks cautiously, calmly and deliberately, which makes him seem very modest. But now, when he presents the "invisible challenge", he grins proudly: This trick helps him to make a quick decision in ambiguous situations. To do this, the software will let the mouse pointer disappear briefly or delay the time after which a letter appears on the screen after an input. "The user does not notice that at all, but his brain automatically reacts to it" - and this reaction is highly individual, if measured accurately.

"I know how terrorists and attackers think," says Turgeman. Before becoming a digital entrepreneur, he had hunted hackers for six years in the elite unit 8200 of Israeli intelligence. Turgeman seems to have learnt a lot from the digital espionage force: when he quit his job, he developed firstly a technology that can filter and intercept conversations from noisy environments, and then an app for mobile payments. When he observed the first fraud attempts, he came up with the idea for Biocatch. "After all I had the knowledge from the secret serviec how to track and identify attackers online."

Unit 8200 in the military intelligence service Aman is the reason why Israel has become a hotspot for cyber security. There are many like Avi Turgeman. For example, Trusteer, an Israeli start-up company with a computer espionage background purchased by IBM in 2013, has developed a system for behavioral authentication ("Trusteer Pinpoint Detect"), which it presented to the public about half a year ago - after Biocatch. Since then, Turgeman feels like the Biblical David, who was not only faster, but also hunted out the first customers of Goliath IBM.

"We have the more disruptive technology," says product manager Golan. IBM Trusteer relies on fewer detection factors and has no "invisible challenges". They continue to explore sophisticated algorithms, says Yaron Wolfsthal, head of the IBM Cyber Security Center of Excellence in the Negev Desert. He looks like the Turgeman counterpart: large, established, self-confident and accuracy is not as important to him as to Turgeman either: How exact the predictions of the IBM system are, he could not say. "We are constantly working to make our system better and better."

Germany lacks not only such a secret service unit, but also a certain carelessness about privacy. Although there are approaches to such research, they still seldom end up in products. A typical example: more than five years ago, scientists at the Ludwig Maximilian University in Munich (LMU) were already working on a smartphone that would use the data from its sensors and entries in all apps to determine whether it was in the hands of a thief, and if so then lock itself. A shrug of the shoulders is all you get today if you ask the people involved what has become of it. Nothing.

Whereby there is no lack of need. "Security is still an unsolved problem, because many users are undermining it," says Florian Alt from LMU. Therefore, the latest trend is to keep people out of the whole thing, as behavioral biometrics does: the user does not actively identify himself, he is identified. "We can observe extremely well what people are doing today," says Alt," right up to the doorknob, which in the future may be able to recognize homeowners by the way they walk towards the house and how hard they press the door handle." The door would then only open for the right person; the key a thing of the past. This is how it should work on the Internet, Alt hopes. His team at LMU is one of the strongest university groups in Germany, and is trying to reconcile usability and security. The Center for Digitization of Bavaria funds the Munich researchers with 1.2 million Euro to explore the opportunities of behavioral biometrics. Alt emphasizes: "Part of the research also consists of determining user acceptance." He even wants them to decide how much privacy they are willing to give up for more comfort.

Avi Turgemann experiences the difference in security cultures during negotiations with a (of course unnamed) German bank: "They are worried because our service is in the cloud" - and not on their own server. But that can be changed." But perhaps these banks are also afraid of the reaction of their clients. Do they want a former intelligence agent to be able to calculate their arm length and cognitive abilities to produce an unmistakable digital fingerprint? Both Avi Turgeman of Biocatch and Nir Stern of Trusteer emphasize that they have no private information about the bank clients; at least not their names. Therefore, they insist, they do not need their consent;it was not about personal data.

"It's misleading to say that's not personal information," says Angela Sasse, professor of Human-Centred Security at University College, London. "From the point of view of computer science, we know that large datasets can remove anonymity." Those who have enough information can draw conclusions about the individual. In addition, a technology that uniquely identifies people on the Internet without their knowledge and involvement easily arouses desires, warns Sasse. "For targeted advertising, that's an issue." The computer scientist has often observed that companies have set up and trained their systems with seemingly harmless applications in order to offer them to the advertising industry for a lot of money. "Such technologies are introduced through the back door without taking social costs into account." And in the world of post-Snowden, one can easily imagine more delicate applications than penetrating advertising.

Security expert Amir Herzberg of Bar Ilan University in Tel Aviv knows all about the authentication and tracking scene and has worked with all sorts of methods to identify people on the Internet. "We have more than enough problems with privacy issues," he says. Despite all the assertions about the safety of behavioral biometric profiles, he has seen too many vulnerabilities to believe that. And if they were hacked that would be a particularly serious problem. Herzberg warns: "Unlike a password, a normal citizen can hardly change his biometric data."

IBM researcher Yaron Wolfsthal is visibly annoyed by such reservations. "When will we finally stop worrying?" he asks. "Computer security is a cat-and-mouse game: We always have to be one step ahead of the hackers. We benefit more from this technology than it costs us."

However, this can be seen differently. One could also ask: How much is our freedom worth to us? If security costs us personal freedom, it is expensive to buy. But for many, the decision has already been made. Turgeman's algorithms alone monitor two billion transactions per month. During the approximately ten minutes in which you have read this article, BioCatch has observed, evaluated and learned almost half a million processes. Without the clients noticing - and without being asked.

Süddeutsche Zeitung, 05/21/2017

The engineer and the neurologist

Rosalind Picard only wanted to develop a bracelet that measures the stress of autistic people. Then it turns out it might save lives. But this is where the problems begin.

By Eva Wolfangel

Rosalind Picard, an electrical engineer at the Massachusetts Institute of Technology (MIT) in Cambridge, USA, could not know that student stories would lay down the pattern in her life when in June 1999, a young man came to her doorstep. And she had no idea how much coincidences like this would determine her success. Fortunately, it was in her nature to be open to it.

At this moment in June 1999, Rosalind Picard is wondering whether the new field of research of wearable computers that she helped to build should actually be called wearable computing - "Do we really want to go with the abbreviation WC?" - when one of her students knocks and shyly asks: "Can you help my brother? He can't understand emotions, he's autistic." Picard has been working for several years now on how computers can recognize people's feelings. The path through facial expression seems promising to her; using photos, her algorithms learn for example whether a person is happy or sad, angry or disappointed.

She is happy to see the young man at her door and invites him in. Finally, there is a good application for her research! Autistic people such as her student's brother could benefit from computers deciphering people's emotions. Her enthusiasm is greatest when she feels she is doing something good, so she intensifies her research and equips not only her student's brother, but also numerous other test persons with small computers and an application that should tell them what their counterparts are feeling by means of their facial expressions.

Eighteen years later, Picard is standing in a hall in Heidelberg in front of thousands of participants at a computer science conference and reporting on this meeting; the beginning of her success story. She knows how to captivate her audience; she makes dramtic breaks and her listeners hang on every word. "We had 70 percent accuracy at that time ", she calls into the hall with an accentuated "at that time" and a grin on her face: 70 percent of the emotions were correctly interpreted by her system at that time. "Today", she continues, "today we have measured more than four million test persons from 75 countries." The logo of a company appears on her slides:

Affectiva. Picard co-founded this company, which holds the world's largest emotion data store. "Today we have 90 percent accuracy," she advises the conference. And that's just the beginning of the story.

A conference break gives me the opportunity to pluck Picard's sleeves, but not immediately. She is surrounded by young researchers; all have questions for her, and everyone dreams of saving the world one day like their great idol. She steers the cluster to the coffee bar, very slowly, making sure not to miss a question; her concern that younger people benefit from her experiences is obvious. Shortly afterwards, those of us who manage to meet her in the tranquillity of an adjoining room will learn of her doubts. "It's not that easy to determine emotions by facial recognition," she says. "Try it here." And indeed: a false smile is interpreted by the app as real cheerfulness, and if one puts on a look of concentration the app interprets it as dissatisfaction. The algorithms are guided by similar patterns as humans but lack context and intuition, so misinterpret more than most people. "A forehead wrinkle can mean concentration as well as anger," she adds,"or just age." Fortunately, the story continues.

Back in 2007: Rosalind Picard's career at MIT advances rapidly: She is now a full professor and famous in the Computer Science scene for her research on wearable computing. But one thing has never changed: she takes every request seriously, and has never forgotten how to listen. So, one day, one of her test persons, an autistic man, dares to tell her the truth: She is on the wrong track. "I have no problem understanding your emotions," he said,"but you don't understand my feelings."

At this point she realizes that an autistic people are not going to be helped by algorithms that read facial expressions. "Autistic people often seem to be very calm on the outside, but they are upset inside", says Picard. Even for close friends and relatives their facial expressions remain mysterious. So Picard begins experimenting with wristbands that assess stress levels by measuring sweat on the wrist; the same technology used for lie detectors: If someone is stressed or excited, then the so-called electrodermal activity grows and the skin becomes moist; often imperceptible to that person. Her experiments look promising; she finds that stress correlates very directly with sweat on the wrist - when a student knocks on her door just before Christmas 2007. "Can you help me? I'd like to know when my brother's stressed out."

Rosalind Picard is a scientist who does not research for the sake of research. Every meaningful use case of her technology drives her. So she invites the student in, and finally gives him two of her measuring instruments to use with his brother over the Christmas holidays, "Take both, in case one of them fails." When the young man returns to the laboratory in January, she is surprised at the measured values. The student had misunderstood the instruction: instead of one bracelet he had used both at the same time. And while the data curve on one wrist was quite even, Picard is shocked by an enormous curve on the other. "The kid was stressed like I'd never seen him before." How is it possible that stress changes electrodermal activity on one wrist only? Picard is confronted with a mystery. She asks her student: "What happened on Sunday at 2:00 pm?" The student kept a diary, looked up and said: "Soon after that, my brother had an epileptic seizure."

Epilepsy? Picard has no idea what that is and spends a whole night on Google. Then she starts to read neuroscientific articles. She is buried in literature and finds that electrodermal activity correlates not only with stress but with activity in the autonomic nervous system. She reads about parasympathetic and sympathetic effects; thoughts whirling through her head. But what does this peak on one wrist mean? She doesn't find anything about that in the literature. She finally dares to ask her intern, who happens to be the daughter of a leading epilepsy researcher at the nearby Boston Children's Hospital. Maybe they could talk to each other? The doctor agrees to a meeting immediately. "I was so terribly excited," confesses Picard. Will the doctor take her seriously? Will he be open to the technology? Will they speak the same language at all?

Same language? That's a strange question for Tobias Loddenkemper, the director of Clinical Epilepsy Research at Boston Children's Hospital. Of course not! "We are both highly specialized, each in their field", he believes. But from his point of view it was a stroke of luck that these two different scientists came together. "I wish we'd met earlier," he says. For him, this computer scientist standing excitedly in his hospital door at the beginning of 2009 could be providing an important piece of the puzzle for a research project he had begun in the 1970s but that had come to a standstill. "We knew this signal, we knew this change in the autonomic nervous system was a Sudep marker." Sudep stands for Sudden Death in Epilepsy; the sudden death after an epileptic seizure. Until then, this death was a mystery for the researchers. When exactly did it happen? And why? The problem was that these changes in the autonomic nervous system could only be measured with complex structures in the clinic. "We had neglected that signal." But although Loddenkemper suspected that it could be verified by EEG, the proof was still missing. "And we can't send patients home with an EEG on their heads," the neurologist says. "Especially for children this would be a stigma and not practical."

The situation was tricky: it seemed as if there were markers predicting death, but they could not be measured practically. "It was our good fortune that Rosalind found us," says Loddenkemper.

In 2010, the proof was finally found: Samden Lhatoo, Professor of Neurology at the University Hospital in Cleveland, used data from those who died in hospital to show that certain, conspicuously flat EEG signals shortly before a seizure, also seemed to predict sudden death. Further experiments showed that this tip in the electrodermal skin reaction that Picard could measure with her bracelet correlated very highly with the flat EEG signal that Lhatoo had described. "It's my greatest hope that Roz's sensor can detect seizures and tell us how high the risk of someone dying is,"says Loddenkemper.

With that information, it is possible to save lives, he hopes. From a lot of data from the past, he knows that these sudden unexplained deaths usually occur when the people affected are alone. Something about the presence of other people seems to prevent death. What exactly, science does not know yet, only the correlation is known: anyone who suffers a seizure in company is less likely to die. Picard explains this from her reading of neuroscientific studies as follows: "A place in the brain is influenced by the seizure in such a way that people forget to breathe. All you have to do is talk to them and they'll breathe again!" She founds another company, Empatica, and launches a measuring device that predicts such seizures thanks to various sensors and artificial intelligence, and distributes the device to volunteers.

"And then one day my heart stopped," she says in her lectures, and her listeners hold their breath when she reads the mail sent to her by a mother of an epileptic child: "The bracelet is amazing! We had an alarm this morning, ran into the nursery, and there she lay face down: She had a seizure and stopped breathing. We turned her over, and now she's lying there rosy and asleep."

Picard takes a short break. "The device saves lives."

Does it save lives? Loddenkemper desires nothing more. "I don't want to get these calls anymore from families saying 'My child is dead! I didn't know she was having a seizure!' " He falters briefly. "That's the worst thing that can happen to a doctor." He would love to say that the device saves lives. He also suspects that it does. But he temporizes: "We can't say it for sure." He knows of many deaths from epilepsy where the patient was alone. And he knows Picard's stories about how the device set off an alarm and saved a patient. But would that patient really have died without the alarm? And would the others not have died if someone had been with them? "Recently, a patient with a wristband on his wrist died," he says and sighs. The device had set off the alarm, but the child's parents couldn't get to him fast enough. In this case, the device thus verifiably predicted death correctly, but Loddenkemper would have preferred to waive this proof.

He is also skeptical as to whether simply talking to the patients as Picard propagates is sufficient. "Responding is always the first thing you do – but no one would ever leave it at that." People give medication, they resuscitate the victims, they call a doctor. "We don't know exactly what helps," he says.

One might see this as an exaggeration when Picard talks about saving lives, but one can also see that if Picard hadn't been as she is - enthusiastic, full of zeal and empathy for her subjects, if she weren't so open-minded, if she didn't give a chance to every coincidence, this device would not have been built so quickly. Many of her colleagues in Computer Science are particularly good at building things for only one reason: because it is possible. Many people ask the question about its implications far too late - or not at all. Loddenkemper is convinced: If Roz Picard's thoughts hadn't been caught by the strange imbalance of the data, and if she hadn't happened to replicate an old discovery of brain research, it wouldn't have come so far.

Some accuse Picard of enriching herself on other people's suffering. She has founded two companies and the first, Affectiva, sells emotion recognition to advertising companies for profit. Targeted advertising instead of helping autistic people? The slight wrinkle on Picard's forehead deepens. A sign of trouble, her app might say. "Founding a company always seemed like I was going to switch to the dark side," she says."But we needed the best people, and we couldn't get them otherwise." The money from the marketing companies helps to further the research, she further argues. To this day, she has been at odds with her entrepreneurial existence because of such accusations, which clearly wear her down. "I would have had an easier life without these companies," she rues. Then her forehead clears again, the unmistakable bright smile returns to her face:"But today I know that people live because Empatica builds these devices."

At the end of the conference, Picard is still surrounded by young researchers. She can hardly move, and her colleagues are waiting in vain for her to join them for dinner. "I can only encourage you," she says over and over again to the young people around her. "If you have an idea, work on it." "But what about the FDA? Do we have a chance?" asks a student. Many wearable computing developers are at war with the Food and Drug Administration which controls medical devices, because the FDA wants scientifically solid proof for statements like Picard's: "My device saves lives." But Picard's fighting for them: "At FDA there are some very smart people," she says. "They're open to ideas." One has to pay tribute to her, because she herself is struggling with the fact that such proof is hardly possible. "It’s not possible to prove this causally," she says, and for the first time this day, she looks a bit downcast.

As long as the FDA does not approve her device as a medical product, it is merely an "expensive toy", as epilepsy specialist Loddenkemper puts it. He wants Picard to find a way to convince the FDA. "The data are so important," he says,"I don't want to get any more calls about a child dying during the night. Preventing that motivates me every day." The data could not only be used to predict the seizures of individual patients; it could also look for general patterns in the population, predict who will fall ill and which medications might help prevent that. But the only data available so far is based on patient self-disclosure. "They come to the doctor every few weeks, can't remember very well and sometimes don't even notice seizures themselves," says Loddenkemper. "Fifty percent of the data we have on epileptic seizures so far is false. What does that mean for drug studies? " he asks rhetorically, and answers his own question: "They contain mistakes because they are based on questionable data."

And then he makes it clear how much he believes in the causality he will never be able to prove: "We can't deny the device to anyone." Some time ago, some of his colleagues wanted to prove the effectiveness of parachutes against gravity. They published an article in *The Lancet*, "but they couldn't find a control group to try without the parachute." The whole thing was a joke, but Loddenkemper can't laugh. He doesn't even want to try to find a control group that doesn't use the bracelet. "That's not ethically correct," he insists. And Rosalind Picard doesn't have the heart to even finish this thought.