

**STEM
COMPETENCES
AND
EDUCATION
IN FABLABS**

As a metal worker, Martin's day starts with a production plan in order to avoid downtime of the machines, as its daily load needs to be maximized. As soon as he knows what to do, he adjusts the machine. He does that by installing the tools, adjusting the clamping and the feed mechanisms so that the program is able to work with a specific machine setting.



Name
Martin Gottfried

Age
42 years

Country
Czech republic

Company
NTS Prometal Machining s.r.o.

Studies
secondary vocational school

METAL WORKER

Before the start of the actual production, it is important to check the graphical simulation of the production, to make sure that there is no collision in production and everything is set as it should be. Then the first piece goes in production for quality control, on which the dimensions, the surface quality, etc. are monitored and fine-tuned. If everything is OK, the production can be started. Martin has to work closely together with colleagues from other production areas such as welders, locksmiths, and fitters because together they have to match all the operations on the product to achieve the desired results. But he also discusses the work with the master of production, and he meets colleagues from the tool shop, the technological department and the control department.

“ Students have to be prepared for the upcoming era of automation and robotization of manufacturing enterprises.”

Martin: “I have to work closely together with the colleagues from other production areas, but of course I also discuss the work with the production manager, and I meet colleagues from the tool shop, the technological department and the control department.”

What are important qualities for the job as a metal worker?

“Of course you need to be technically focused and instructive because it's about working with new technologies and machines. But it is also crucial that you are able to take care of your work in a consistent way. When you are responsible for your work in production, you cannot be negligent. You rely on yourself and your judgement, and you have to sign up under every product you make. Also, it is important to be willing to learn constantly: in our industry is what you need to know today maybe not enough for tomorrow.”

Speaking about tomorrow: what will be important for the future of your job?

“Students have to be prepared for the upcoming era of automation and robotization of manufacturing enterprises. They have to be prepared in school of course, but it also helps that they are active and eager to learn themselves. Show interest, and you will learn automatically!”





Name
Elpiniki Pappa

Age
27 years

Country
Greece

Company
ScieCo

Studies
Bachelor in biology
Master in neuroscience



Elpiniki did not follow a conventional science trajectory. She started a study in biology, finished her master's degree in neurosciences and started to do research in a laboratory. After she did several studies, she switched to education and communication. Hence, she is a scientist in an educational nonprofit organization, using her knowledge in communication about science.

SCIENCE COMMUNICATOR

Elpiniki: "As science communicators, we try to bring science close to people of all ages. We build programs to make students come closer to science, such as focus groups for students and hands-on STEM activities. We organize also a science festival to get more engagement for science. And our work pays off, as we see that people get more empowered and have more awareness of people in science."

Do you need specific science knowledge for this profession?

"Of course, you need to know the scientific topic that you are communicating, because you have to avoid misconceptions. And we are also working together with researchers when we do collaborative projects in research centers. But besides that, it is also important that you are good in communicating science conceptions. People who don't know about the technical details of your job have to understand it in order to collaborate. The founder –my boss– is also a biologist, but we are also working together with creative people who work in theater, people who are specialized in communication, and business people from companies."

"To people with a scientific background I would say: this job is not clearly connected to research, but you still experience the satisfaction of research, because you can help researchers and scientist to bring their topic close to the public."

“ We try to bring science close to people of all ages. ”

Besides having good communication skills, what is important when you work as a science communicator?

"Teamwork is very important. Each person has different skills or different tasks to do, so you have to know how to guide people. But you also have to be able to make a switch when it's needed. I can be both part of a team and the leader. Having an optimistic and friendly attitude is also important when you work in a team. Collaboration is very important for me, because you cannot just focus on your own tasks without caring about the others. I admire someone who takes action; it is essential to see possibilities and take action upon it. And of course, creativity is an important asset when you work as a science communicator, because you have to create something new."

"Organization skills, creativity and being able to work in group are very important. I can be both part of a team and the leader. You have to be able to make that switch when needed."

Anton is a project manager at Uddeholm, a company specialized in producing tool seals.

Anton: "I am not talking about screw drivers, but about molding tools for automotive plastics. We also produce the molds of iPhones, tv's, etc. The plastic is PET. In short, we produce steel, melt it, form it, and sell it. To produce these tool molds, the company needs specialized machines, such as turning machines and saws."



Name
Anton Johansson
Age
28 years
Country
Sweden
Company
Uddeholm
Studies
**Mechanical engineering
Master in materials**

INDUSTRIAL ENGINEER

"Right now we are going through an expansive phase, as we want to increase our capacities. As a result, we have to handle our investments. To do this in a proper way, we need studies, for instance: 'what kind of accessories do we need?' Currently, I am in a pre-study phase, and I have to present the concepts to the board."

As a project manager, Anton is in contact with every department of the company. He works together with colleagues of engineering, but he also communicates with the production personnel (which consists of over 900 people), and people from marketing, administration, R&D and logistics. He also has to work together with people from other companies, such as suppliers of equipment.

"I am good at detecting tasks and handing these over to the right specialists."

What is the most important when you have to work together with so many people?

"I am a social person. I speak a lot to people, and this is very valuable for me. My communication skills come in useful in my job. It is crucial to be socially talented, because you have to communicate with people from different backgrounds. On the same day, I may have to report to the CEO and also talk to the production personnel.

For me, honesty and reliability are very important. I depend a lot on other people, and my job is easier if I can delegate something to others

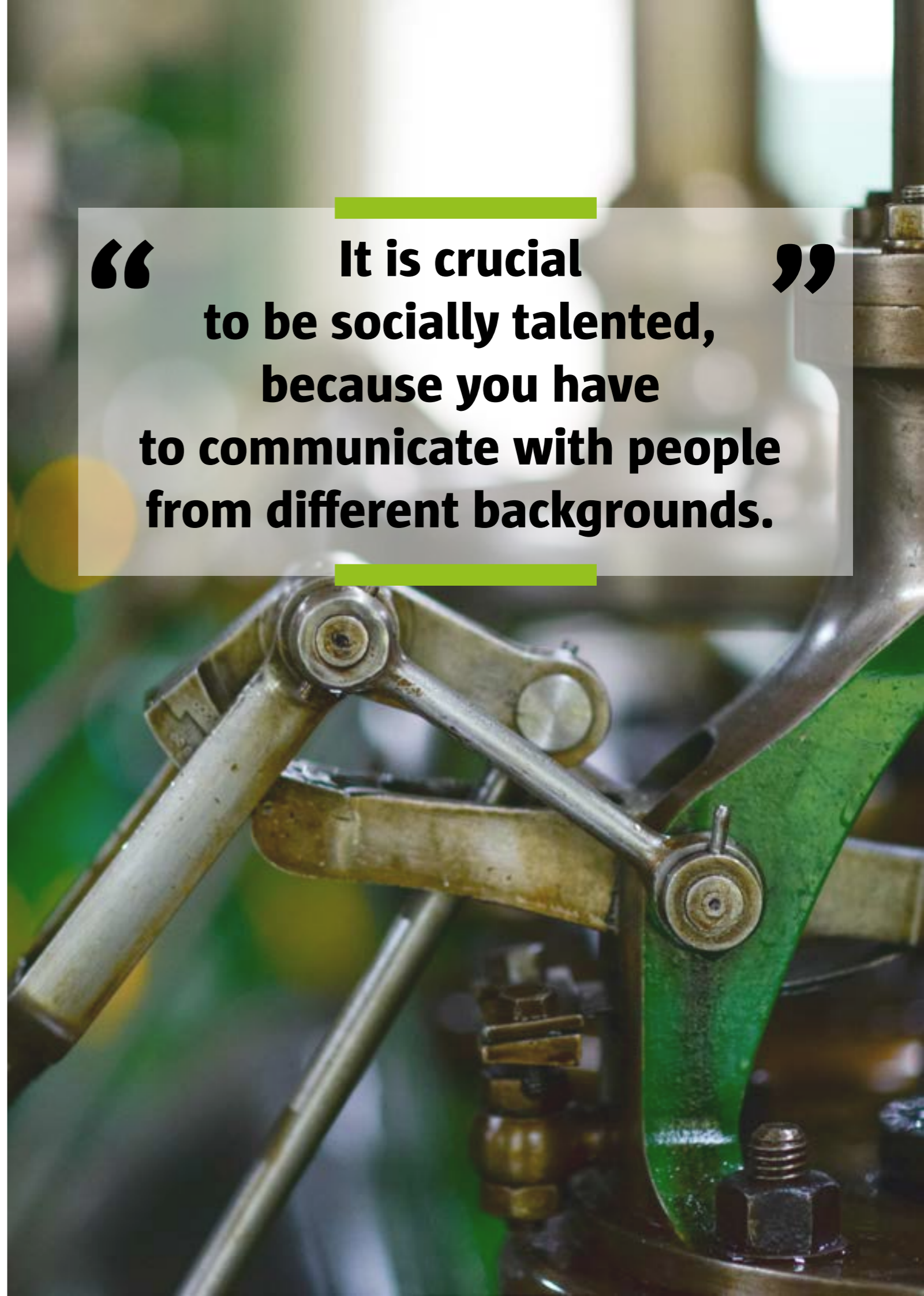
without double checking it. Therefore, I always say that you don't have to be afraid to ask help from people that have done this for a longer time. If you act like you know something, but you don't, you will make mistakes and will disappoint others. In a big company you find people with tons of experience. Pick up from specialists! Eventually, after a few months you will become more confident."

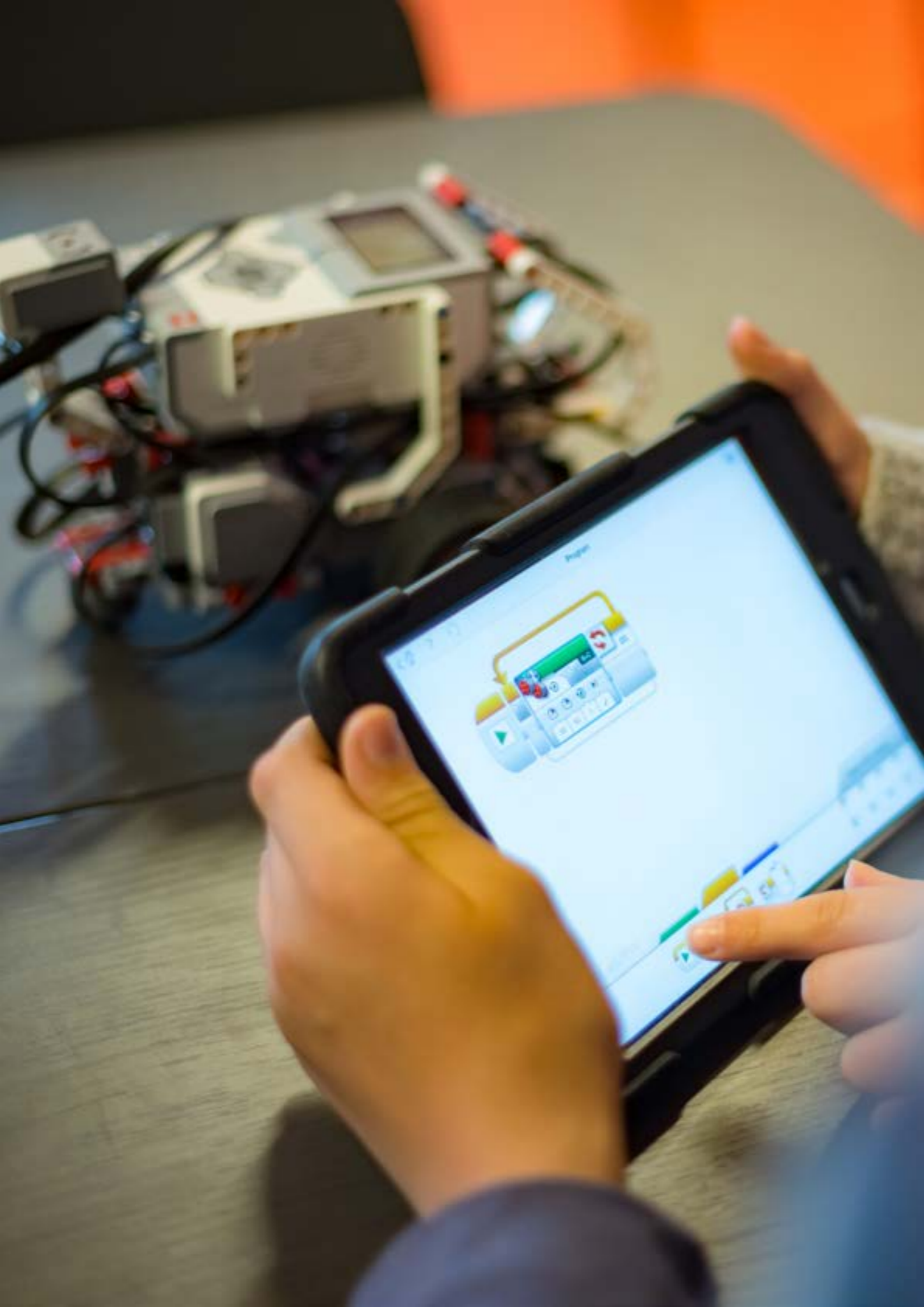
What did you miss in your own education?

"I enjoyed mathematics and languages, but I would have liked more emphasis on the language part. It facilitates the communication with the other personnel. In a large company you will meet people from multiple countries. And people talk better in their own language. Right now I am learning Spanish. I'm struggling, but it's still useful.

Of course, technical knowledge is very useful in the educational program, but you face it every day, and you have more chances to pick things up and learn it on the work place. For languages, that's less evident."

“ It is crucial to be socially talented, because you have to communicate with people from different backgrounds. ”





Name

Veselin Rusinov

Age

26 years

Country

Bulgaria

Company

Robotika

Studies

Technical school

Studying computer sciences



Veselin is an entrepreneur in STEM education. Together with a team of 3 other people, he runs a startup in robotic courses. Veselin has a lot of teaching experience in robotics, and decided to start his own company with different materials after dreaming about doing things his own way. On weekdays they develop new materials and do the business work. In the weekends, they give the robotic courses.

COMPUTER SCIENTIST

in robotics education

Veselin: "If you want to achieve something, you have to do a lot of work. Right now, this is hard work, but I am hoping that in two years we will have less work, because we can use the earlier developed materials."

Running a startup means meeting a lot of people. They meet headmasters and teachers of public schools. They have business partners both for the company itself and the robotic projects that they are developing. They are always looking how they can collaborate, and sometimes elements of the courses are developed together with business partners.

What materials are you using in the courses?

"We use Lego Mindstorms, BBC Micro:bit, and Arduino. For the younger students we use Electro Dough. This looks like a classic dough you can mold, but it conducts electricity. We mold for example the night sky, we use diodes as stars, and when it's finished the night sky lights up. It is fun for the children: they do something with their hands, and at the same time we are teaching them basic electricity. We were very pleased when we found out the existence of this material. The same company makes also clothes that are made from electricity components. This could be a fun project for the future."

What is important when you are working as an entrepreneur in robotics education?

"First, you need good education. You should know what you are doing of course. Second, you have to be really patient. To be an educator is hard, and you stumble upon different kids and different problems. You have to be patient to make it work with them. You should also be eager to learn, and willing to try new things and technologies."

“ Problem solving is mainly about developing new solutions.

You also have to develop your own skills, not only by using new tools, but in a personal way as well.

The technologies are developing really fast, it can be old in two days. You really need this will to develop. Problem solving is mainly about developing new solutions. You also have to develop your own skills, not only by using new tools, but in a personal way as well. In this way you can come up with strange and innovative ideas that sometimes can be used very well. Coping with problems is important!"



Name

Kevin Roelstraete

Age

37 years

Country

Belgium

Company

Algemene bouwonderneming Vandebussche N.V.

Studies

Civil engineer



Kevin is project manager in construction. He started as a site manager, being on the yard constantly. Now, as a project manager he visits multiple yards a day, because he supervises two or three simultaneously. Kevin states that he has more freedom since he is a project manager, but that he is of course dependent on the appointments that are planned for the work day.

Kevin: "The biggest part of my job consists of

CONSTRUCTION ENGINEER

calculation. Does a certain material fit the requirements? We offer a price, the customer agrees, and we make sure to stay within the budget. You have to think whether something can be done more cost-effectively, and is the quality in that case still sufficient? As you see, there is a lot of financial administration involved. You have to set up contracts, and find alternatives when necessary. This is something that is often overlooked in education: the competences to negotiate with others and to agree on prices is a big part of the job."

“ **You have to communicate clearly, in order to minimize misunderstandings and extra communication.** ”

What are the other talents of a good construction engineer?

"Of course you have to be technically skilled. And a lot of the required competences depend on the work you are doing as a construction engineer. If you work as a contractor, you will have to make a lot of calculations regarding the stability and the used technology.

But if you work as an operator like me, you are on the road a lot and you have to establish contacts with external actors. In that case, you have to be able to handle pressure, be socially skilled, and be adequate in your communication.

As a project manager, I train and coach. The ideal site manager is punctual, motivated, and dares to speak up when something is not as it should be. He or she should also be good in administration and keep track of the supplies."

Besides the construction chiefs, which other professionals do you meet at the yard?

During yard meetings, I also discuss the work with architects, contractors, safety coordinators and people who deliver energy performance certifications I also meet subcontractors, because we do not carry out all the work with our own people. The building shell and structure is our job, but we count on other professionals to do the plumbing, electricity and roofing. Every operator should be aware of the fact that working hours can be long and irregular. That's because we work with international subcontractors who work on other moments."

"You have to know that working hours can be different when you work with international subcontractors. Some countries work in weekends, and you will be on the road a lot."

“ You have to be open minded, and you cannot be stubborn. When you are able to change your mind, then you are able to learn new things ”

Name

Emma Skogman

Age

27 years

Country

Sweden

Company

Stora Enso

Studies

Bachelor in biotechnology

Master in chemical engineering

Emma is a process engineer at Stora Enso, a company in the forest industry which is specialized in pump and board milling. She works at production, where she analyzes potential problems, looks for solutions (e.g. investments), works on long time technical production projects, and optimizes the efficiency of the production.

PROCESS ENGINEER

Emma: “I do not only look at the technical side of efficiency, but I also pay attention to the way we manage the people. For instance: do the operators need more instruction? So it’s not only about engineering, it’s also about people management.”

What is the best background for a process engineer in your field?

“I would say you can be a process engineer with any engineering background. Don’t only think with the head, but also with the heart. You have to be engaged and motivated! Do something you like. I did extra activities in the summer in this industry as an operator quite early. Now I work with the operators, and I understand the way of thinking much better. So I would definitely recommend doing extra activities in this field.”

“Another thing I would recommend is to be part of a sports team. Team work is always going to be important, and if you like sports, try to be in a team. I used to play soccer, and it is a fun way to learn how to be part of a team. If you like travelling and meeting cultures, you can go on an international exchange. Language knowledge is very beneficial because it opens doors. If you aspire to work for an international company, a study experience abroad can be an asset.”

What part is currently underexposed in education, considering your job requirements?

“I would focus more on communication skills. For me it was an eye-opener that my social skills were as important as my technological skills that I learned at the university. You have to know how to effectively communicate with different kinds of people. How do you read people? How do you approach different opinions? You don’t have to agree with everyone, but you have to be able to step into their shoes. You have to be an active listener and ask a lot of questions. And if you can communicate your ideas and your thoughts clearly, then you are on the right track. It’s sometimes more about how you say it than what you are saying. Luckily, it has been one of my strengths that I am an open person.”

“I would also recommend courses in economics. Targets, goals,.. it was all new to me. You have to have a feeling how business works. It would be a good thing if students took part in a business as well. You have to realize: even if you have a very cool idea, you have to finance it. Calculate how much money you need.”

“You have to be able to take initiative. No one is going to give you an instruction about how to do your job. You need to see it, and take initiatives to start solving the problem.”



As an electrician, Jiri's main activities include pulling material, storing electrical cables, switching on electrical machines, connecting switchboards, sockets, lights, and motors. He also often repairs machines and electrical hand tools. Before he starts with the job of the day, he thinks about an action plan, and writes down the necessary electrical material he will need. Sometimes he is working at heights, and in such situations he has to borrow lifting equipment.

Name

Jiri Marek

Age

49 years

Country

Czech republic

Company

NTS Prometal Machining s.r.o.

Studies

Secondary vocational school



ELECTRICIAN

Jiri: "My main tools are my head and hands. Furthermore, I use isolated keys and screwdrivers up to 1000V, various types of pliers, yokars (which is a stripped knife), gola keys, milling cutters, SDS and AKU drills, angular grinders, drills etc. I also use an electric tester, voltmeter, ammeter, ladder, and of course always protective work gear, which consists of galoshes, dielectric gloves, shield, rescue hook, shorting set etc."

Do you consider your job as dangerous?

"It is very important that you are responsible, maintain the rules and respect the regulations. Yes, sometimes we work in a risky environment, and then you have to respect the safety guidelines. For every task it is necessary to respect the safety, so that I do not endanger myself and my co-workers. You also have to rely on your other colleagues to do the same. For every task it is necessary to respect the safety, as not endanger myself and my co-workers. You also have to rely on your colleagues to do the same. So trust is very important."

"I always wanted to work with electricity, and was intrigued and attracted by its invisibility. Since I was a little boy, I was creative and I started with the Merkur kit. I always wanted to know how electricity really works. Where does it come from, how can you use it? The plumber sees a tangible fluid in the pipeline, but for us electricians it is different. At the first sight it is

inconspicuous, invisible. And that makes it dangerous too.

For an electrician, it is important that you don't mind working at heights, and that you enjoy the thrill."

“ As an electrician, you have to be creative, and be able to improvise. ”

Besides respecting safety, are there other things that you consider crucial for your work?

"It is important to constantly educate yourself and be interested in new trends. But if you enjoy something, then you intrinsically want to know as much as possible about this field. And it should be fun! It simply cannot work without that element of fun. Also, as an electrician you have to be creative, and be able to improvise. Anyone who enjoys it, is good at creative thinking, has respect for electricity and is not afraid of it can become an electrician."

Andrea works as a project manager in the molding industry at Inglass, a company that produces steel molds for the injection industry. Andrea collects requirements for updating new procedures, and makes recommendations to the management. For instance, he has to evaluate the benefits or disadvantages of a trade, such as the effort and the return of investment. Every time a proper evaluation has to be made, he has to propose the decision to the management.



Name
Andrea Tellan

Age
28 years

Country
Italy

Company
Inglass

Studies

Master mechanical engineering

MECHANICAL ENGINEER

Andrea: "It is important to have the technical knowledge on the one hand, because you will have to make acquisitions about the change in technical structure, or the improvement of a product (e.g. type of steel, temperature, pressure). But on the other hand, it is also important to be able to translate this to the management. Managers usually come from two different backgrounds. Some are engineers, and others are business managers who are not always technically schooled. Especially for the latter category it is important to be able to translate the message."

What is the biggest difference between the knowledge you acquired at school, and the experience at the workplace?

"Now, I work for the FCA group of Maserati, and three things are now clear for me, but should have been highlighted through the educational programme. Firstly, how to understand the processes within the company. Secondly, the fact that a company has an administration, sales, design, and engineering department. And finally, some awareness of the structure complexity.

I felt that the technical knowledge in the educational programme was too detailed. We went in deep detail in mathematics, but lost the perception of what is really useful in business. I didn't mind, because I did enjoy mathematics, but now I see that it was totally unclear which part of mathematics was also useful for business life."

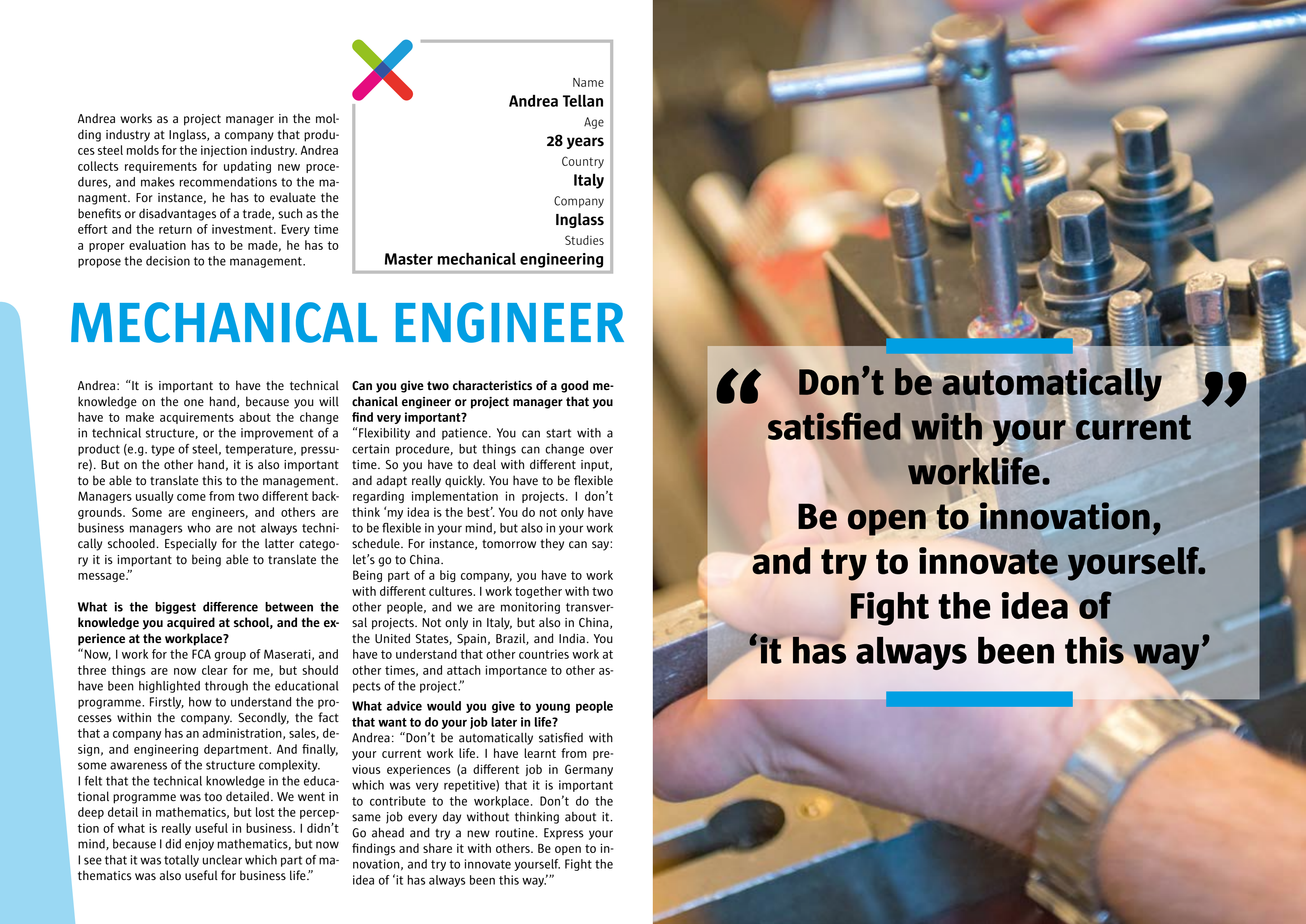
Can you give two characteristics of a good mechanical engineer or project manager that you find very important?

"Flexibility and patience. You can start with a certain procedure, but things can change over time. So you have to deal with different input, and adapt really quickly. You have to be flexible regarding implementation in projects. I don't think 'my idea is the best'. You do not only have to be flexible in your mind, but also in your work schedule. For instance, tomorrow they can say: let's go to China.

Being part of a big company, you have to work with different cultures. I work together with two other people, and we are monitoring transversal projects. Not only in Italy, but also in China, the United States, Spain, Brazil, and India. You have to understand that other countries work at other times, and attach importance to other aspects of the project."

What advice would you give to young people that want to do your job later in life?

Andrea: "Don't be automatically satisfied with your current work life. I have learnt from previous experiences (a different job in Germany which was very repetitive) that it is important to contribute to the workplace. Don't do the same job every day without thinking about it. Go ahead and try a new routine. Express your findings and share it with others. Be open to innovation, and try to innovate yourself. Fight the idea of 'it has always been this way.'"



“ Don't be automatically satisfied with your current worklife. Be open to innovation, and try to innovate yourself. Fight the idea of 'it has always been this way' ”

The bio databank is a big laboratory where pathological tissues are collected. When someone needs surgery, and during the operation the tissue is removed, that tissue is being sent to the laboratory. There, the doctor can investigate the tissue in order to diagnose the patient. If the diagnose has been made, they collect a part of the tissue to prepare it for further investigation and storage. If necessary, the tissue is processed and subsequently stored in a refrigerator.



Name
Mieke De Wilde

Age
39 years

Country
Belgium

Company
Biobank UZA

Studies
biology and biochemistry

BIO-CHEMIST

in a bio databank of pathological tissues

Mieke: “We do not only collect tissue, but also blood, urine or other body fluids. We’ve chosen to collect a lot of tumor samples, in order to facilitate cancer research. If researchers need tissues for their cancer research, they can retrieve it in our bio databank. Therefore, it’s important that all tissues reach the lab and are being investigated.”

“ You have to see which things need to be done or known.

You have to be able to think along with the researchers in the lab, to detect the research needs.

What do you enjoy most in your profession?

“I like it that my job is so versatile. I began as the only employee in the laboratory of the bio databank, but as we grew more people came to work here. And now I am the quality manager of the laboratory. I supervise the work and evaluate whether it’s useful and done efficiently. In the laboratory most work is of a practical nature, and we follow up projects and discover

new ways to collect materials. But we do also research work in collaboration with researchers from biotech companies or PhD researchers from universities.”

What do you consider important to be good at your job?

“You definitely need a background in life sciences. The specialization is of less importance, but it is necessary to understand what the researchers are doing. You also need to be pro-active and see which things need to be done or known. You have to be able to think along with the researchers in the lab, to detect the research needs. An analytical mindset comes in useful! Also, social and communicative competences are very important, because in a hospital you work together with other people, such as nurses and doctors.


Also, it is important to be good in time management, and to be creative. Creativity has been suppressed in education, but in my job it is extremely important. You have to be creative in your thinking in order to have a mindset of a researcher.”





“ It is important to learn about the methodology. The data can change, but a good methodology in conducting research and searching applications is always useful. ”

Depofarma, Paola's company, focuses on immunostimulants (substances that improve the activity of the immune system) and substances to modify the gut microbiota. The activities of Depofarma are split up in research and product development.



Name
Paola Dalla Zorza
Age
46 years
Country
Italy
Company
Depofarma
Studies
Pharmaceutical chemistry

BIO-CHEMIST

in the pharmaceutical industry

Paola: “For the research line, we conduct clinical trials on the effectiveness of immunostimulating products to eliminate fungi and bacterial infections. We also conduct clinical trials on the modification of gut microbiota after assumption of our substances. This takes place in collaboration with universities. In the universities we study raw materials, perform in vitro studies, and we carry out all the clinical trials. For the product development, we produce raw materials. However, we do not produce the final product ourselves. Depending on the activity we are focusing on, we work together with different professionals. We usually work with biologists or bio-engineers because they are able to work with cells and bacteria.

For instance, we need people who can work with the next-generation technique of ‘sequences’. This is a way to detect all the bacteria in a certain organ, which form a sequence or a chain. For the clinical studies, we work with people with a medical background. And when we develop final products for pharmacists or physicians, we work with people who are able to make formulas.”

What is the main challenge in your job?

“You have to be able to find final applications for your invention. It's not only about content knowledge, it's also about finding applications. You have to be a good problem solver to work in this field. You can not just wait for an answer,

instead you have to be actively engaged in solving a problem. Even if you know many things, it is not enough to create your own solution. So the challenge for young people is to not only think about the theoretical knowledge (e.g. bacteria), but search for new applications (e.g. the use of certain bacteria in the medical field). Problem-solving and curiosity are key when you are looking for good applications”

“In school you should also learn to be open for learning experiences. Every day you can discover something new. Therefore, it is more important to learn about the methodology, than to learn about the data. Because the data can change, but a good methodology in conducting research and searching applications is always useful.”

How do you foster your own curiosity?

“I usually read a lot of literature, scientific papers. Interesting findings may lead to new opportunities. Everything can improve your knowledge, and being open-minded helps to gain new insights. I also try to be in contact with clinicals, and I listen to the biologists and immunologists' point of view. Listening to others can help you to broaden your ideas. We do different kinds of jobs every day. We follow up on the research, we check the certifications for products, we investigate the market... Working in the pharmaceutical field is a job with a lot of variety.”

Cveta works as an agronomist and her job content depends on the season. In spring for instance, she starts to grow summer plants which she is planting in the ground, potting or repotting. Also in her spare time she likes to work in the garden, which shows her love for horticulture



Name
Cveta Petrova

Age
44 years

Country
Bulgaria

Company
Everyone

Studies
Agriculture high school

AGRONOMIST

Cveta: “I have a big garden myself with onions, garlic, and a lot of flowers. At daytime I work in a garden, but in the evening I love to take care of my own garden. With a glass of wine in that case.

When at work, she works together with landscapers, but she also communicates with people outside her workplace. For example, Cveta calls her friends who are also working in agriculture when she encounters a new problem. To be good at this job, Cveta indicates that three things are important:

1. Love nature.

“The most important thing is that you love nature. And with that, I mean all kind of life. You are not only working with plants, you are also working with other life above the ground and in the ground. For instance, you have to appreciate the function of insects. Working in nature goes together with a certain emotion. My colleagues are like me: they love what they are doing, they feel a connection with the flowers, the plants, the landscape in general...

You have to be sensitive in many ways. You have to appreciate the beauty of leaves, trees, science (and STEM in general), and connect with it on an emotional level.”

2. Have patience.

“You cannot just quickly grow a good flower or vegetable garden. To have good results, you have to be persistent, and keep repeating the same little tasks over and over again. The little things add up to something big.”

3. Keep on learning.

“I think that you don’t finish education when you leave the university. You have to keep on learning your entire life. No one knows everything. That’s why I call my friends when I encounter a new problem. We can learn a lot from each other’s experiences. I am hungry for more information, and every day I encounter new challenges. That’s always the case when you work with nature.”

What did you learn from being an agronomist?

“I learned that you have to keep on working. Only when you persist, you will get results. I also try to tell that to young people. You cannot do something impressive or something big everyday. But what you can do, is to give everything of yourself every day. When you work with nature, you learn that you get results in the long term. In spring trees are flowering, after two months they give fruit.”

“

You don’t finish education when you leave university.

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Transversal skills

- Willingness to learn
- Problem solving skills
- Creativity
- Ability to communicate (on different levels)
- Being pro-active
- Sense of entrepreneurship
- Being able to work in group
- Flexibility

Advice to young people

- Don't be afraid to ask questions
- Be patient, and learn to work hard every day. The little things add up.
- You can pursue one particular job with different backgrounds.
- Team work will always be important: try for instance being in a sports team or youth movement
- Do something you like: you have to be engaged and motivated
- Be open to innovation and try to develop yourself

Challenges for education

- Preparation for the upcoming era of automation and robotization
- More practice
- More freedom for students to do things and learn by their experiences. Not only as receptors, but as part of the educational procedure
- Methodology is more important than data: every day brings something new
- Technical skills are important, but economics and languages are also important in a business setting. (e.g. targets, business goals,...)
- How to understand the processes within the company, and be aware of the structure complexity