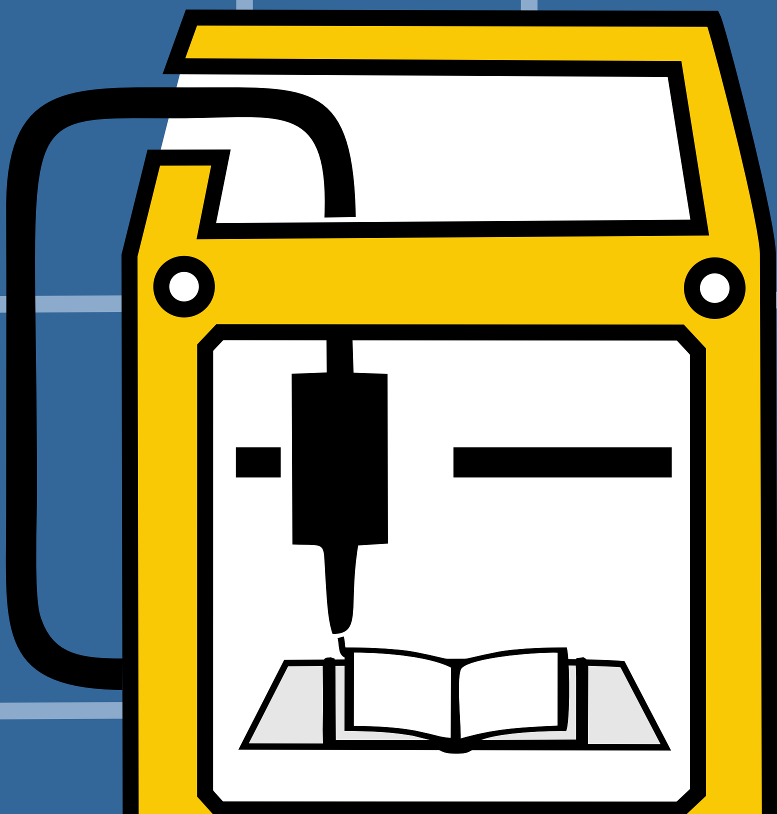
BASIC TECHNOLOGICAL TRAINING AND SCIENTIFIC THINKING FOR EMPLOYABILITY



EXPERT COURSE

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TECHNOLOGY AND DIGITALIZATION

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ÍNDICE

AREA 1

DEVELOPMENT OF SCIENTIFIC THINKING

AREA 1: DEVELOPMENT OF SCIENTIFIC THINKING
D.U.1 – CRITICAL THINKING AND SCIENTIFIC THINKING: How to apply the principles of critical thinking and scientific thinking to day-to-day work in a technology company: posing problems, conducting experimental tests, characterizing materials and devices, reporting the results obtained, or drawing conclusions from them.

PILL 1 – INITIAL IDEAS

Express in your own words which are the essential ideas behind the terms "critical thinking" and "scientific thinking".

HELP	Critical thinking is something that applies in all fields of human life. Possibly thinking is what makes us human, and although there are many definitions or ways of understanding what critical thinking is, behind all of them is the idea of analyzing our own way of thinking. It is easy to realize that we continually receive information or messages that convince us of certain ideas, make us reach conclusions, or make decisions. Believing all that information at face value leads us to make mistakes and to be manipulated. In the professional field, critical thinking has a huge importance: problems have to be continuously solved and decisions made on the basis of technical information that we can find from different sources (results of experimental tests, statistical reports, etc.). You can find a good approach to the concept of critical thinking in *The Mini-Guide to Critical Thinking Concepts and Tools,* by Richard Paul and Linda Elder http://www.criticalthinking.org/ (consulted on the 7th April 2021).
	You will find many websites in which scientific thinking is clearly explained. It starts from the **scientific method** proposed during the Renaissance by philosopher and writer Sir Francis Bacon (1561-1626), arising in opposition to magical thinking, and is based on a series of steps: collecting facts, understanding said facts through laws, formulating hypotheses to explain what happens, comparing the experimental results with those expected in the hypothesis, and predicting new events. Scientific thinking is related to characteristics like objectivity, rationality, skepticism, the ability to demonstrate and verify, or systematicity. All the scientific and technological development of the last centuries has been based on the scientific method.

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FINAL REMARKS

There is clearly a parallel between critical thinking and scientific thinking when talking about science and technology, and throughout this course we will try to make these ideas land in a multitude of examples. We show how deepening our understanding of the processes by which we learn new concepts, techniques or methods, draw conclusions, and make decisions helps us make less mistakes, be more aware of our capabilities, and more effective in our professional activity and in other fields of our personal and social life.

PILL 2 – SURVEYS

How a question is asked can influence the answer. Let's see that with an example: in a survey on the vaccine against COVID-19, the question asked was "Would you be willing to get vaccinated immediately, would you prefer to wait for the secondary effects to be known, or would you not be willing in any case?". We compare it with an alternative formulation of the same question

"Would you be willing to get vaccinated immediately after the vaccine is approved by the European Medicines Agency, would you prefer to wait, or would you not be willing in any case?".

Do you think that the number of respondents who are willing to get vaccinated immediately would be the same in both cases?

HELP	In reality, the two questions are the same because in no case will a vaccine be administered if it is not approved by the European Medicines Agency, the same as any other medicine, but the fact that the second question explicitly mentions that the vaccine has been previously studied and approved by a trusted body seems to induce higher confidence.
	In both ways of posing the question, the second answer option generates distrust of the first. The option of waiting to know the effects of the vaccine administered to others seems to mean that the side effects of the vaccine are not known, implying that it has not been sufficiently studied before being marketed.

	What is mentioned in the previous point is true; after the pharmacological study and approval of any drug and authorizing its commercialization and clinical application, the possible side effects are still analyzed for a long time. Between 1953 and 2013, 462 drugs were withdrawn from the market due to adverse effects detected during their clinical application. This will also be done for years with vaccines that are being administered now.

FINAL REMARKS

With this activity, we just want to show how language can influence the way one reacts impulsively. In the question posed there is a fundamental background issue, which is the trust one has in a given source of information or in a certain person, the media, a web page, a private company, or an official body.

We are continually consuming medications. We do not have the capability of analyzing whether a drug is good for us or not, if it is going to have side effects, if it is going to cure us, etc. We trust doctors who prescribe it, and they in turn trust official bodies: the national agencies and the European Medicines Agency, which are the ones who have studied the clinical tests of a medicine and have determined if it is safe and effective against a given disease, and that the benefits it has to cure the disease are much greater than the adverse effects it may have in a generally very small number of cases.

Here, our critical thinking has to be aimed at analyzing what source of information we trust, since we do not have the capability to analyze the specific drug in depth. So, then, what gives credibility to a source of information?

PILL 3 – THE FALSE EXPERIMENT

Two sales representatives from a company of domestic reverse osmosis water purification equipment come to our house. They tell you that they have your address because a friend of yours -whom they already visited and who bought their products- gave it to them.

The first thing they want to show you is how bad tap water actually is, and to do that they perform several experiments in which they compare osmotic water (purified by osmosis) with tap water. In one of the experiments, two metal electrodes (two metal rods) connected to an electrical generator are immersed in a glass of tap water, connected to a circuit with a light bulb and a switch.

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As electricity circulates, the bulb turns on, and when this is done with osmotic water, the light doesn't turn on. But the most striking thing is that the glass of tap water turns brown, looking really gross. This does not happen with osmotic water, which remains transparent. Their conclusion is that tap water contains very unhealthy substances in dissolution. Do you believe this? Look for information on this and write about what may be happening.

HELP	The first step would be to understand what reverse osmosis is, and you can easily learn about it online: it is essentially a filtration process. Water has a great capacity to dissolve salts, and tap water from different places contains salts from the soil itself, plus additives to prevent bacteria and other microorganisms to grow in it. The osmosis process does in fact largely remove these dissolved products from the water.
	Thus, if we compare tap water to osmotic water, we are comparing water with dissolved salts to water that doesn't. The electrical conductivity of water effectively depends on its salt content, since they decompose into positively and negatively charged ions. When connecting the voltage source, the electrodes becomes positively and negatively charged, attracting the opposing ions and producing an electric current. Naturally, if there are no dissolved salts in the water, there is no ionic conductivity, no electric flow, and the bulb does not turn on.
	The funniest thing is that tap water turning brown isn't related at all to "very unhealthy substances" in dissolution. What is actually happening is that negative ions chemically react with the positive metal electrode oxidizing it, and the brown color comes from the iron oxides of electrode itself, not something that was previously in the water.

FINAL REMARKS

The experiment is clearly a fraud. They are deceiving you, making you believe in the need to buy the osmosis equipment because the tap water in your house is not healthy. Regardless of its taste, tap water passes sanitary controls and is safe to drink.

What is the deception based on? First in creating trust by telling you that a friend of yours sent them, in telling you that they are professionals, and in showing you supposedly scientific experiments; secondly, in the fact that you don't know the physical phenomena behind what they are showing you

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(osmosis and ionic electrical conductivity); and, above all, thirdly, they trust that you will make a decision before being sufficiently informed (and by alternative sources) of what they are showing and selling you. To do this, they will also surely tell you something along the lines that they have a very good offer at the moment, creating the artificial need to react fast, so you don't have time to reflect and inform yourself thoroughly.

In this case, critical thinking would be to reflect on how you are going to make the decision, if you have sufficiently understood what this equipment they offer you actually is, if you can trust the information that they have given you or need to contrast it, if you sense a manipulative intention in the person informing you, or if you really have a need for that water purification equipment. If you look for other information, there will actually be people who will tell you that osmotized water -precisely because it does not contain salts- is not the best option either.

PILL 4 – PERSUASION TECHNIQUES

The behavior of an individual comes from many influences from their social environment. The way you behave, even when speaking of the most basic behaviors -like standing upright, communicating, or eating- are not learnt by yourself, but from other people. There are many examples of how the environment influences our actions and our decisions: how do parents or teachers make children follow their instructions? How do politicians get you to vote for their party? How do salespersons get you to buy their product?

Persuasion is the intention to influence a person to change their behavior or attitude. Sometimes we are the ones who try to persuade others, and others we are the object of that persuasion. There are people whose profession involves convincing others: salespersons, politicians, religious figures… and techniques have been developed to do precisely that, which have been studied very thoroughly, and which persuasion professionals learn and apply.

Let's see one example: there are tactics based on the principle of coherence. Being coherent is something highly socially valued, because it is associated with stable, honest, and rational people. We have internalized that our actions should be consistent with our previous actions, and also in a certain way with our ideas or values. Well, this quality can be exploited to establish persuasion techniques.

When someone needs you to do something that is going to be costly, one of the tactics can be to first ask you to do something related, so simple that you practically cannot refuse, and then once you have done it to ask you to do what they really wanted in the first place, and which is consistent with the previous act. Another tactic is to give you false information to get you to do something, and then giving you the correct information, since you probably will not turn back at that point (for example, offering a product with certain characteristics at a very low price; when you have already decided to buy, you have even discussed it with others, suddenly that model is not available anymore, but there is another one with the characteristics you liked but at a higher price; they count on you still making the effort and buying it for consistency sake).

Look for examples of these persuasion tactics that you have been involved in. Did they convince you?

HELP	These are two types of tactics that are very present in advertising campaigns: “you can buy this motorcycle for just *X*€”, and then that model is either sold out, takes months to arrive, or has serious problems, and the only available models are more expensive.
	Another example: “subscribe to this audiovisual platform for 1€ per month until December”. Then, when it is time to start paying the full price of the subscription, you don’t cancel it.
	You might find an example of this in a different area, in which they don’t want to sell you something, but to get you involved in a given activity, maybe you have found yourself in this case in your educational center.

FINAL REMARKS

Persuasion techniques based on principles of social psychology have been well studied and developed for centuries. People who make a profession of it are perfectly knowledgeable about these techniques. One of the bases of their effectiveness is the difference between the knowledge of these techniques of the person who wants to convince you of something and yours.

On the other hand, there is the fact that on many occasions we act quickly, without carefully analyzing what we are told or the information we are given. An important component of persuasion is getting you to answer quickly, then the very principle of consistency will keep you from backing down. It is very interesting to read about these techniques (the field is much broader than this example); it is easy to understand them and they are quickly recognized in everyday life. Look for information online if you are interested in knowing them.

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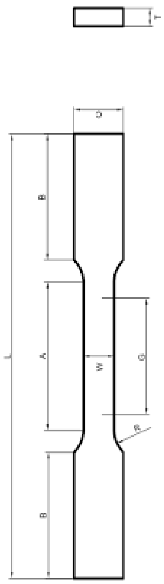
AREA 1: DEVELOPMENT OF SCIENTIFIC THINKING

D.U.2 – UNDERSTANDING OBJECTIVES: Understanding the global objective of the test that is going to be carried out, as a result of the work meetings in which you participate.

PILL 1 – MEHANICAL STRENGTH TEST OF A PLASTIC

A cast filament 3D printer is used to make a series of ABS parts (co-polymer of acrylonbitrile, butadiene, and styrene) to stress test. A tensile testing machine is used to take the data, with samples in the shape shown in the figure.



You have to print 10 of those test pieces with a 3D printer, test them, and compare the result with 10 other tests of injection-created pieces that have been ordered from an external company. You will measure the elastic modulus and the stress and elongation at break.

Why do you think this experiment is being carried out? What do you think might be the reasons why the results will be different between the two series of samples? Think about what questions you would be interested in asking before doing the test, either due to curiosity or because you think that the answers are important for the quality of the results obtained.

HELP	You may have already had the opportunity to see this type of mechanical resistance tests on different types of materials: metals, ceramics, or plastics. One of the first things you will learn about is the variability of the results. Many experimental factors have some subjective influence: the tension in the jaws holding the sample, a lack of homogeneity in the sample's dimensions (thickness for example), and probably defects in the sample (small cracks or notches in the edges, pores…); defects can be the points where the crack begins to spread and eventually breaks the sample. For this reason, the samples used are generally like the figure, to minimize the effects of gagging, and avoiding them to be mechanically cut from plates. This is also why it is necessary to have a high number of repetitions of the test and to follow

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	protocols to obtain the mean values of the parameters and the uncertainty of the measurements.
	Here may lie the interest of the proposed essay: a 3D-printed part is done so layer by layer, so its whole mechanical strength will depend on both the adhesion between layers and the presence of pores.

FINAL REMARKS

Material property data is used in making the calculations that will determine the dimensions of a piece to withstand the forces it will be subjected to when in use. These data are supplied by the manufacturer and have been determined with this type of test, but in certain manufacturing processes, the manufacturer's values may not be representative of what the company ultimately gets.

This is a clear example of it: manufacturing a piece by injection (in which the molten plastic is injected at a high pressure into a mold) is clearly different than 3D-printing it (by gluing layers upon layers) and you have to precisely determine these properties under conditions that reflect well the manufacturing process. Not only that, the parameters of the printing process can decisively influence layer-to-layer adhesion and therefore the resistance of the resulting piece. These tests can allow to optimize the production process.

PILL 2 – TEMPERATURE CALIBRATION

An oven is used to make heat treatments on already molded plastic parts; it is important that the temperature program on the sample is accurate. The oven has a temperature probe inside, on a side wall, but the temperature needs to be calibrated on the sample itself. The procedure is to create plastic samples with different sizes (10*10*20mm, 20*20*30mm, and 30*30*40mm) with a hole in the center, into which a 1mm diameter temperature probe will be inserted.

The probe cable comes out of the oven and a thermometer measures the temperature of the sample; that temperature is noted, along with the temperature measured in the oven outside the sample. That way we can calibrate how the temperature evolves inside a piece by knowing also how the outside temperature evolves. We expect there to be distinct temperature differences between probes (the inside and the outside one) if we heat the oven at a constant speed or if we set a constant temperature. Thus, tests will be

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carried out first by heating increasingly at 1º, 3º and 5ºC/min and then with constant temperatures of 50º, 80º, and 120ºC.

Think about the following questions: why we are measuring samples of different sizes? What difference do you expect between the results with large pieces and smaller pieces? Why do we measure at different heating rates? What difference do you expect between the results of faster and lower heating speed?

HELP	First think about what property of the material is responsible for there being a difference of temperature in the piece between its center and the inside of the oven and the outside the piece. This property is called *thermal conductivity*, which is generally low in plastics.
	Since the transmission of heat through the plastic piece from its surface to its core takes time, when heating at a constant rate, the temperature increases more slowly in the center of the part than at the surface. The difference between the outside and inside temperature will be greater the larger the piece is, because the heat has to go through a larger layer of plastic that acts as a thermal insulator; the difference in temperatures will also be greater the faster the oven temperature increases.
	However, when a constant temperature is programmed in the oven, the inside of the piece will also take longer to reach that temperature than its outside, but both will be the same in the end.

FINAL REMARKS

The exchange of heat between two bodies is something slow and that has inertia to it, which is sometimes important. As the properties of *thermal conductivity* and *specific heat* can be very different from one material to another, carrying out specific tests in the precise conditions in which the part was manufactured may be necessary.

Another question that could be raised is the fact that in this experiment we are comparing the temperature measured by two different devices: the probe inside the oven and the one inside the piece. It is important to previously check the calibration of these two thermometers, lest they were already measuring differently before the test. Each device has their own calibration protocols.

PILL 3 – QUALITY CONTROL

Your company produces a drug delivery system to treat burns: it is a tissue impregnated with a gel that contains the drug. The gel is produced from a solution of a gel precursor, a naturally occurring protein to which you add the required amount of the drug and a chemical gallant that gels the solution by binding the proteins together. The different components are introduced into the machinery that doses, mixes them, and impregnates the tissue to be later cut into the desired pieces and packaged under sterile conditions.

The protocols for calibrating the equipment and receiving the material, as well as the handling of the whole process are perfectly specified and followed at all times with complete faithfulness. The quality control system foresees characterizing a total of 5 samples from each batch. The drug content and the rate at which it is released when immersed in a control solution are measured in these samples, and a sterility control test is carried out to measure the presence of bacteria.

If there is a control of all the devices and tools, and the conditions of the whole process are kept constant, why is a quality control of each batch of the product necessary? What do you think can make the properties of the product change from one batch to another?

HELP	We have given an especially critical example, since it is a medicine: the production conditions are exhaustively reviewed, each procedure carried out is included in a written document (batch document), the starting materials are certified, all equipment and devices have strict maintenance protocols, and yet failures occur.
	Any machine can fail at any time; in this case for example the systems that dose each of the components of the gel, or those that ensure the mixture to be uniform. The particular batch in which the failure occurs will not meet specifications and may even be dangerous.
	No matter how much a manufacturing procedure is standardized, certain subjectivity and the possibility of human error cannot be ruled out: recently, news broke about a pharmaceutical company that produced two vaccines against COVID-19, due to human error, confused the ingredients of both vaccines, losing millions of manufactured vaccines that could not be marketed.

FINAL REMARKS

Although this is an example of the production of something where the quality of the product directly translates into its safety and is therefore especially critical, the conclusions can be extended to any industry-manufactured product. Critical analysis of possible sources of error is important in any activity in a company.

PILL 4 – MEASURING DENSITY

The density of silicone samples will be measured for samples shaped like cylinders of approximately 5mm in diameter and 5mm in height. The balance weighs with an accuracy of a tenth of a milligram. The procedure consists of weighing the dry sample and then weighing it again on a dish immersed in ultrapure water (Mhor's balance), measuring its density is based on Archimedes' principle.

Find out how to calculate the density of the sample from those two weight values. Wouldn't it be easier to measure the diameter and height of the sample with a caliper, then weigh it dry, and calculate its density by dividing its average mass by the volume calculated from its dimensions?

HELP	According to Archimedes' principle, the sample immersed in a liquid undergoes an upward thrust equal to the weight of the liquid it displaces, meaning the weight of a volume of water equal to the volume of the sample itself.
	In this way, the weight of the sample immersed in water will be: $$m_{immersed} = m_{dry} - V_{sample} \cdot \rho_{water}$$ from where the volume of the sample can be calculated easily, because the density of water (ρ_{water}) is known very precisely: $$V_{sample} = \frac{m_{immersed} - m_{dry}}{\rho_{water}}$$

	and from it the density of the sample (ρ_{sample}): $$\rho_{sample} = \frac{m_{dry}}{V_{sample}}$$
	Note that the measurement can be very precise because the mass is determined with a precision of 0,0001g. This does not mean that there are no other sources of error; special care must be taken with the formation of air bubbles on the surface of the sample when submerging it in water, because they act as "floats", making the observed measurement smaller than the real one. In any case, this kind of measurement is considerably more precise than the geometric measurement of the sample volume. First, because that measurement is based on the fact that the shape of the piece is that of a perfect cylinder, in order to calculate its volume as: $$V_{sample} = \pi r^2 h$$ where r is the radius of the base and h is the height of the cylinder. That probably already introduces a significant error. On the other hand, the measurement made with a caliper would have a margin of error 0,1mm.

FINAL REMARKS

When determining any property of a material it is important to have a prior idea of the precision of the equipment being used, and to decide if that precision is sufficient for the purposes of the test. If you don't have clear information about the precision of the specific equipment to use (maybe you don't know the possible different sources of error, like in this case the formation of air bubbles), the measurement of a series of several samples and another series of control samples (samples of a material with the same characteristics as ours but with precisely known density) will allow you to assess the uncertainty of the measurement.

AREA 1: DEVELOPMENT OF SCIENTIFIC THINKING
D.U.3. – FORMULATING A HYPOTHESIS: posing a hypothesis before conducting a test or trial is a key element of the scientific method. It allows you to both anticipate the result and analyze the possible obstacles that may arise in the process. It consists of generating a prior idea of the results you expect just with the prior knowledge you have, to analyze and contrast the final result.

PILL 1 – THE OVEN TURNS OFF

A problem has arisen with an oven, a laboratory device in every way analogous to the domestic kitchen oven. The temperature is programmed and the oven has a regulator (thermostat) that turns on and off the electrical resistances with which it generates heat, so that the programmed temperature is kept constant.

The issue is that when the oven has been running for about an hour, it turns off, as if the power supply were cut off. Repeatedly turning it off and on then has no effect. Later, when its inside temperature becomes lower you can turn it on successfully as if nothing had happened.

Before calling the technical support service, which will take time, do you have a prior idea -a hypothesis- of what may be happening to the oven? Can you think of an easy solution?

<table>
<tr><td rowspan="3">HELP</td><td>Raising an hypothesis is sometimes a matter of common sense, based on previous experience, other times a “happy idea”, but most of the time it requires getting informed first. Fortunately, the amount of information that circulates on the internet makes it easier for many people: just try to describe the situation in a search engine (like Google) with a simple sentence or keywords; for example “oven turns off after a while”.</td></tr>
<tr><td>Surely you’ll find forums where someone has asked the same question and perhaps gotten answers. These answers can be contradictory, some of them even absurd, so you now need your common sense to think about what might be more reliable, either due to the source it comes from (anyone may answer, from a repairperson to private individuals, or someone who has already had your same issue and has repaired it).</td></tr>
<tr><td>You may find answers like: “your oven’s thermostat might be damaged”, or</td></tr>
</table>

	"some ovens have a protection system that turn the power off when a certain temperature is exceeded, you can buy it for 5 to 10€", or "I had the same issue and the brand's technician changed something on the back of the oven's inside, but I don't know what part it was". Which of the three would you consider as the basis for your hypothesis?

FINAL REMARKS

We are left with the final decision: Is an emergency solution possible? Would you try to check yourself if the damaged part is the one you think it is, and try to replace or repair it yourself? What do you think it depends on doing it or calling a technical assistance service? As a technician in your company, what are you going to suggest to your boss as a solution?

PILL 2 – WILL THE CABLE HOLD?

You have to display a product on a trade fair booth by hanging a piece weighing 72kg from a steel frame. In order to create the illusion of it floating in the air, you have to use transparent nylon thread. Can it be done, will it hold the weight?

HELP	It can be done, but it depends on the type and thickness of the nylon and how many threads you use. First, get information on the maximum load that a nylon thread supports depending on its diameter. There is a lot of information from many manufacturers, because it is used as fishing line.
	You will notice that there are many types of thread with different characteristics, but as a guide, 0,6mm diameter thread can support 21kg. The manufacturer's website recommends working with a safety factor of 100%, meaning to use a thread that resists twice the load it will bear. Thus, 6 or 7 of those threads holding the piece from different points of the steel frame should work. But what else is there to consider?
	You have to also consider the strength of the connections of the thread to the piece and to the frame, since these will probably break before the thread itself. Conventional knots will not work, it will be necessary to look for specific joining systems (there are also many such elements in the field of fishing). Another important factor you'll have to consider is the elasticity of the thread: how much

	is it going to stretch when you hang the piece?

FINAL REMARKS

The hypothesis should be that what is proposed is indeed feasible, and what you need is to find a complete technical solution, not settle for intuitive ideas.

PILL 3 – WHAT WILL THE RESULT BE?

You make 100cm^3 of a 0,1M solution of acetic acid and water. Before making the calculations of the quantities of the two components to be added, do you know how much acetic acid will the solution approximately contain? 0,01g, 0,1g, 1g, 10g? What tools or devices would you use to measure the volume you have to add? And what would you do if you just needed 52cm^3 of that solution?

HELP	First of all, do you know about molarity? Do you know the molecular weight of acetic acid? The molecular weight of acetic acid is 60g/mole. A 0,1M solution has 0,1 moles of acetic acid per liter of solution, and therefore you will have to add 6g to the water to get 100cm^3 of solution.
	How do you do this? You can weigh the necessary amount of acetic acid in a beaker with a precision balance and pour it into a 100cm^3 volumetric flask, which will give you an accurate measure of the volume. In order to minimize the error that could be introduced by the drops that could remain in the beaker in which you have weighed the acid, you could dilute it with some water before transferring it to the flask. If you needed a different volume of solution, you can always prepare a slightly larger amount that can be measured accurately and pipet the amount you need from that. You can also calculate the amount of water contained in that volume of solution and measure it with a precision pipette.

FINAL REMARKS

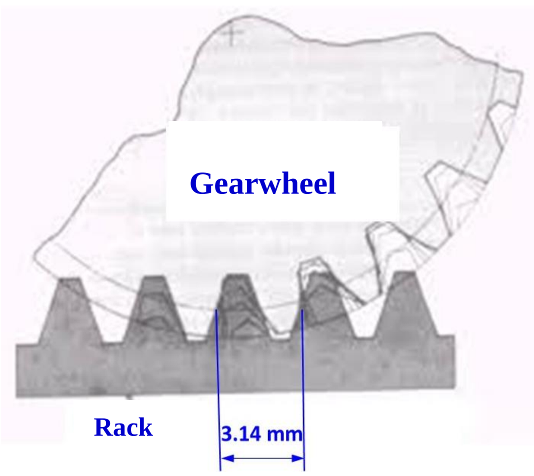
It is very useful to make a hypothesis about the result of any calculation that you are going to do: How should I get? Obviously you can be wrong, because you will do it based on intuition or previous experience of other similar calculations that you have faced before, but the key is not to get it right.

The interest of doing this is that the result of your calculations will be striking if it does not match what you expected, allowing you to analyze it critically; it is a way to detect numerical errors that occur frequently.

An extreme example is that of the nursing staff administering medications to patients in a hospital following the written guidelines from the physician treating those patients. If the guidelines are simply followed and there is a numerical error (a comma moved one place when typing on the computer, for example), there can be dire consequences. Critical thinking is basic in these professionals; you must have an initial first idea (even if it is approximate) about the order of magnitude of the doses that are usually administered of a given drug, and you notice a dose that seems too high or too low (based on your hypothesis), go check it with the doctors.

PILL 4 – HOW FAST WILL THE RACK MOVE?

A stepper motor turns a modulus 1 worm gear at a constant speed of 30 revolutions per minute (rpm). The worm gear meshes with a 50 tooth gearwheel, which in turn meshes with a rack, as seen in the figure. How fast will the rack move in mm/minute? The dimensions of a tooth of a modulus 1 gear are seen in the picture.



Before doing any calculations, first think and note if the rack will move to the right or to the left when turning the gearwheel clockwise, make an approximation of the travel speed (for example 0,1mm/minute, 1mm/minute, 10mm/minute, 100mm/minute…), and then do the calculation.

HELP	Think about how many turns the gearwheel makes for each turn of the motor, and how much the rack advances for each turn of the gearwheel.
	You don’t need to know in detail the geometric characteristics of the gears, the shape that the teeth must have, and what makes the movement of the rack to be continuous, making constant contact between the teeth of the gearwheel and those of the endless screw or rack; you have enough data with the advance of the rack each time a tooth of the gearwheel passes, as seen

	in the picture. In any case, it might be interesting for you to understand it. The modulus of a gear determines the size and shape of the teeth; the number of teeth a gearwheel has in turn determines its diameter. Find a website that explains these dimensions.
	Each turn of the worm screw advances the wheel one tooth, and therefore the rack advances 3,14mm. With the motor rotating at 30rpm, the rack will advance 94,2mm/min, regardless of the number of teeth on the wheel.

FINAL REMARKS

Were you right regarding the order of magnitude or were you wrong by a lot? Think about why: was your initial idea right and you made the wrong calculations, or were the calculations right and your initial estimate wrong?

Establishing a hypothesis will helps you to be critical of the solution you find for a problem, and in case of making an error, to detect it. Having an initial idea, even if it is only indicative of what the solution to the problem should be, or even a wrong initial idea, will encourage you to critically analyze the result obtained, and where appropriate, look for a possible error.

AREA 1: DEVELOPMENT OF CRITICAL THINKING
D.U.4. – DESCRIPTION OF A TEST: how to describe a test carried out and the results obtained, so that other members of the team can understand them, analyze them, and help in the process.

PILL 1 – HOW TO WASH AND DRY LABORATORY GLASSWARE

In chemistry, the precision in conducting an experiment that involves a chemical reaction requires using materials devoid of any impurities, because these could interfere by reacting with the reagents or products involved in the experiment.

Glassware must be washed immediately after use, because it may not be enough to use liquid or powder detergents, you may need to use solvents or specific corrosive mixtures that require a good knowledge of the material that has left residues in the glass.

After washing the materials using the appropriate brushes or swabs, it is rinsed with tap water and then distilled water, so that when drying there are no traces left of the salts tap water has. Lastly the material is dried, and there are different procedures to do this: if the material is going to be used immediately, a way to dry the glass is to rinse it with acetone and let it evaporate, since it removes the remains of distilled water. Look online for a full laboratory glassware washing and drying procedure. Why do you think acetone is used for drying? How is acetone waste managed? Would ethanol work as well? Explain it in a few lines.

HELP	The difference between leaving a glass to dry when wet with water or with acetone has to do with the volatility of the liquids. Acetone evaporates very quickly at room temperature, without heating or using a, air stream.
	Usually, any residual solvent or chemical reagent must be collected in suitable containers and classified by category so it can be properly treated by a specialized company. In any case, acetone is relatively harmless to the environment. Look for information on why this is the case.

FINAL REMARKS

The methods of washing and drying the materials used in the tests both in chemistry laboratories and in other industrial laboratories are perhaps the first things that are explained to anyone who starts working in them. Many of the details of the procedure are not intuitive, so stop to think about those details and try to understand the reasoning behind each of them.

PILL 2 – FRYING AN EGG

When you explain to another person how to do a test that you have done many times, the difficulty may lie in the details that you already consider obvious and as such don't explain, so the person doing it for the first time does not know them. This example can be useful to put that in evidence: trying to explain something that seems very simple to you, like frying an egg. Write a protocol on how to do it as if it were a laboratory experiment, not a cooking recipe, so give specific details: what pan to use? What oil? How much of it?... Make it so that whoever is going to do it doesn't have to decide anything.

HELP	It is not that easy. Try to explain what has to be done adding a minimal explanation of why it has been decided this way. For example: it is important that the egg is submerged in the oil; so to use less oil, use a non-stick frying pan of 16cm diameter. Add XXml of XXXXXXXX oil, so its level is at least XXcm, etc. Think about all the details, what kind of spoon is used? Does the oil have to be moved in any way?
	You can highlight any necessary warnings to avoid accidents or mistakes. Can the oil splash? What can you do to prevent the egg from sticking or breaking?

FINAL REMARKS

You can give this to a friend or acquaintance to read, to see if they notice that you have forgotten something or that there is something that isn't properly explained.

PILL 3 – CALIBRATING A THERMOMETER

Digital thermometers are often used to measure temperatures in industrial processes. The picture shows an example of a platinum resistance thermometer; a kind of thermometer based on the fact that the electrical resistance of a platinum wire depends linearly on temperature. The thermometer is a circuit that measures the electrical resistance of the platinum wire enclosed in a rod, which is the probe that comes into contact with the item whose temperature you want to measure, and matches the resulting resistance value with a temperature.

The *Pt100* probe has a resistance of 100Ω at 25ºC. In order to match electrical resistance values to temperature, the thermometer has to be calibrated, which is done with two set values: pure boiling water at the pressure of 1 atmosphere (so 100ºC) and a bath of pure water plus ice, also at the pressure of 1 atmosphere (0ºC).

Look online for a thermometer calibration procedure. You can check the website: https://www.infobioquimica.com/new/2015/12/15/procedimiento-recomendado-para-la-calibracion-de-termometros-en-the-clinical-laboratory/ for example, but look for others if it is not active or you simply prefer another source. Take a look at how the protocol has been written, the information they give, the references cited.

Briefly explain what a set value for calibrating a thermometer is, and why these are used. Which details of the procedure have caught your attention? Explain why they seemed important to you. Do you think there are differences in the calibration of different types of thermometer; mercury-based, thermocouples…

HELP	Phase changes (like liquid-vapor or solid-liquid) take place at different temperatures depending on pressure and the substance in question. Thus, for example, if ice at -20ºC and 1 atmosphere is heated, its temperature will increase until it reaches 0ºC, which point it will begin to melt and form the first drops of liquid water. If you keep heating it, there will be more and more liquid water and less ice, but the temperature will stay at 0ºC (the melting temperature of water) until all ice has molten. This is why this is a set value that can be used to calibrate a thermometer. Something similar happens with the phase change of water from liquid to vapor: the vaporization temperature

	of pure water is 100ºC at 1 atm.
	Water and its phase changes are not always used for calibrations: if the thermometer is to be used in temperature ranges far from the range between 0 and 100ºC, other set values are used. For example, the melting temperature of n-heptane is -90,6ºC, and indium's is 156,6ºC.
	Pay attention to details like how to place the thermometer probe, the position in which it is placed, whether or not the medium has to be stirred, if it is necessary to wait for a while for the measurement to stabilize, etc.

FINAL REMARKS

There are different types of thermometers, but the need to calibrate them is common to them all, and the methods are too. There may be differences in terms of details, such as the time necessary for the measurement to stabilize, because the transmission of heat with the item whose temperature you want to measure may be different in some probes and others due to their size or the material of which they're made. There will also be a difference in the way of entering the data obtained in the software of the device so that it matches the measurements. Once the data have been entered, the test is repeated and then the thermometer must accurately mark the temperatures of the fixed points.

PILL 4 – PROTOCOL TO MEASURE THE DENSITY OF A LIQUID USING A PYCNOMETER

Density is the quotient between the mass of a body and the volume it occupies; to measure the density of a liquid, it is necessary to precisely determine these two values. To do this, we use pycnometers (like the one in the picture), glass containers -usually small- with an extraordinarily narrow neck called "capillary". As it would be very difficult to fill the container with the liquid through this neck, it can be assembled and disassembled thanks to a ground fit that fits perfectly.

To use the pycnometer, the neck is removed, the main body is filled with liquid to the top, and when the neck is placed again, the liquid rises through the capillary and overflows, drying on the outside and becoming completely full. The difference between the weight of the full and empty pycnometer allows us to precisely know the mass of the liquid inside. To precisely measure the volume (the value written on the glass is only indicative) you have to do a test with a liquid of which you know its exact density, for example distilled water. Thus, the only thing we need is a precision balance, and depending on the balance we can measure the density with an accuracy of up to 0,001 g/cm^3.

Could you explain why the pycnometer has this particular design? Write a protocol indicating the step-by-step operations to be done to measure the density of a liquid.

<table>
<tr><td rowspan="3">HELP</td><td>There are different containers with engraved marks that indicate the volume of liquid they contain when the content is made up to the mark with that mark. The error that occurs in the measurement depends a lot on the section of the mouth of the container: a beaker is not suitable for measuring volume because a small error in the leveling means a large error in the

volume. For this reason, volumetric flasks or calibrated pipettes are used to measure specific volumes of the liquid. The volumetric flask has a narrow neck, the error in the leveling translates into a small error in the volume. The pycnometer increases the precision even more with a neck in the shape of a capillary of approximately half a millimeter in diameter.


</td></tr>
<tr><td>The protocol must indicate all the operations to be done to conduct the test, and most importantly, it is not only for yourself, it must be written so that other persons can understand it. Put yourself in place of someone who is not aware of these measures and who reads your protocol; will they understand? Things that you have done many times seem obvious to you, and perhaps you will not write them, yet the person who does the essay for the first time cannot know them.</td></tr>
<tr><td>Don’t limit yourself to writing the operations to carry out, but explain minimally why they are done. This helps a lot to avoid misunderstandings and mistakes.</td></tr>
</table>

FINAL REMARKS

Did you remember to start by properly washing and drying all the materials that you are going to use? You have to also explain how to do that. The experiment is first done with distilled water. You will weigh in an empty pycnometer, then fill it with distilled water, and then weigh it again: $m_{pycn+water}$.

The difference is then the mass of water contained in the pycnometer:

$$m_{water} = m_{pycn+water} - m_{empty}$$

The volume of the pycnometer is:

$$V_{pycnometer} = \frac{m_{water}}{\rho_{water}}$$

Where ρ_{water} is the density of water: 0,998g/cm^3 at 20ºC.

Repeat the test at least three times and thus check how reproducible the measure is, and calculate an average.

Next, repeat the experiment with the liquid of interest. Determine the mass of the liquid in the pycnometer with the liquid and the density:

$$\rho_{liquid} = \frac{m_{picn+liquid} - m_{empty}}{V_{picnometer}}$$

Again, repeat the experiment two more times and average the results.

AREA 2

SKILLS AND ABILITIES REQUIERED BY THE TECHNOLOGY SECTOR

AREA 2: SKILLS AND ABILITIES REQUIRED BY THE TECHNOLOGY SECTOR
D.U.1 – PROCESSES OF ANALYSIS: conducting a comprehensive review, inspecting each component individually, and learning how they interact to produce results, to arrive at a complete understanding of the process or part of it with, to sustain or achieve incremental or transformational improvements.

PILL 1 – PROCESS ANALYSIS

To work in the technology sector, as in almost any sector, it is necessary to understand the processes that your company carries out, and especially all those related to your job, since without a good understanding of them, it will be very difficult for you to follow them, improve them or change them.

In this way, the first step to know the processes that your company carries out will be to answer the question: what is process analysis?

HELP	
	Process analysis is the action of conducting a review and gaining an understanding of business processes. It is a review of the components of a process, including inputs, outputs, procedures, controls, actors, applications, data, technologies, and their interactions to produce results. The analysis covers the evaluation of time, cost, capability, and quality of the processes, and either static or dynamic visual models of it can be used, along with the collection of data from the beginning to the end of the activity, the analysis of the value chain, end-to-end modeling, and functional decomposition.
	To better understand this concept, some typical examples of process analysis carried out in almost all companies are: - Use of resources: analysis of all the resources needed to carry out a process from start to finish, as well as the efficiency of the process, meaning if it could be carried out with less resources than those used. - Distribution analysis. - Analysis of the cycle time: usually aimed at reducing the time of the process.

	- Cost analysis: usually aimed at reducing the costs of the materials used in the process. - Variations of global/local processes. - Total cost of the tools of the process (for example, IT systems). - Impact of the process on internal participants (employees) and external customers and stakeholders. - Impact of the process on the organization's community (for example, environmental impacts) and other stakeholders.

FINAL REMARKS

Note that it is not necessary for all workers to know all the processes of a given company, since depending on its size it is usually divided into different departments or work areas, but it is essential that they know all the processes related to their job and have a global vision of the main processes carried out by the company.

PILL 2 – COMPONENTS OF A PROCESS

The previous showed what process analysis is, this one will focus on how to do that; learning to inspect each component of the process individually. Let's see an example:

A company in the technology sector, mainly dedicated to electromechanical parts repair, receives an order from a client to repair a component that has been damaged. Try to define the complete process, dividing it into the different steps necessary to achieve it.

HELP	To facilitate the analysis process and inspect each component individually, we can answer the following questions: What is the object of the process, meaning, why is that process created? When does the process start? When does it finish? Who is/are responsible for this process? Which stakeholders are involved in the process? What are the controls linked to the process to ensure that it is carried out properly (these can be documentary controls or visual controls)? What documents or control records (documentary controls) are linked to the process to ensure that it is carried out correctly? What management indicators are linked to the process to help to know its performance? Which tasks or activities are carried out one after the other, making up the process itself? What risks may there be for the

	process to fail?
	To carry out a slightly more detailed and written analysis of a process, you can also follow these 10 steps, which will help you define and understand almost any process carried out in your company: 1. PURPOSE: why does the process exist? 2. RESPONSIBLE: who is in charge of the process? 3. DURATION: clearly identify the beginning and end of the process. 4. INPUT AND OUTPUT: specify the input and output elements of the process. 5. STAKEHOLDERS: identify the stakeholders involved in the process. 6. STEPS: describe the steps or activities carried out during the process. 7. CONTROL: identify the process controls that exist in the company. 8. RECORDS: write down the records linked to the process. 9. INDICATORS: identify the process indicators. 10. RISKS: identify possible risks of the process failing.

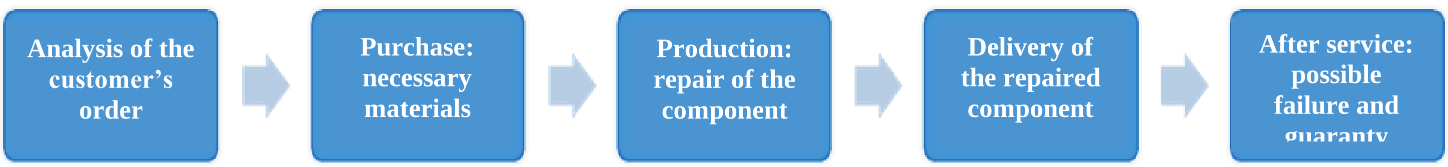
FINAL REMARKS

It is essential for any company that its workers know the processes it carries out; it is not about having an expert technical, scientific, or technological knowledge, but rather having both a global vision of the processes and being able to identify and analyze each of its components individually.

This knowledge allows to rigorously carry out the processes you are responsible for, guide your work team in a proper development of the processes, detect if there are weaknesses in any step of a process that can lead to it failing or errors occurring in it, and make improvement proposals that increase the effectiveness and efficiency of the processes.

Lastly, in order to better understand processes, graphical representations of them can also be made, such as flow charts, which represent the steps followed in a process from start to the end, and for this a series of visual elements are used to help you draw each step that follows a process.

SOLUTION: One of the simplest ways to represent it would be the following:



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PILL 3 – CONTINUOUS IMPROVEMENT

Once we have studied what it is and how to carry out a process analysis by inspecting each component individually, we will go a little further to learn how they interact to produce results, to reach a comprehensive understanding of the process or part of it, to maintain or achieve incremental or transformational improvements.

This is essential, since the main objective of process analysis is to achieve these continuous improvements that will allow the company to develop its economic activity with greater effectiveness, efficiency, and quality.

Continuous improvement of processes, in the process approach, is based on the principle that “any activity can be improved if its improvement is systematically planned, existing practice is understood, solutions are planned and put into practice, results and its causes are analyzed, and the cycle is repeated”.

Let’s go back to the example of the process worked on in the previous pill and try to propose improvements to it.

HELP

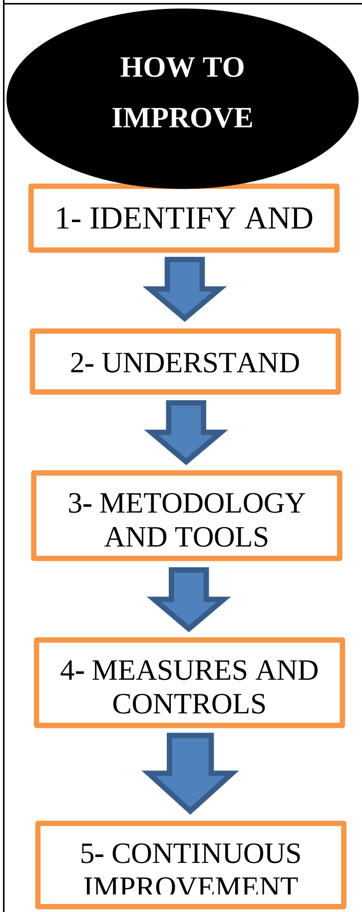
Total Quality Management uses the term “continuous improvement” to refer to the idea of improvement as a problem-solving process. The improvements result from the use of: a) the scientific method; b) tools; and c) a structure to manage individual or group efforts.

As a scientific method, the PDCA cycle is used: Plan, Do (what was planned), Check (the results obtained), and Act (based on said results). This cycle symbolizes the principle of iteration in problem solving, and means making step-by-step improvements and repeating the improvement cycle over and over again. It is carried out through the so-called “improvement projects”, which in general are the following 7:

1. Selection of the topic.
2. Data collection and analysis.
3. Analysis of causes.
4. Planning and implementation of the solution.
5. Evaluation of effects.
6. Standardization of the solution.
7. Reflection on the improvement process.

The tools most used in these improvement are those called “the 7 quality control tools”:

1. Checklist/stratification.
2. Pareto diagram.
3. Cause-effect diagram.
4. Graphics.
5. Control charts.
6. Histogram.
7. Scatter plot or correlation diagram.



Another of the most frequent structures to improve processes consists of following the 5 steps listed below:

1. What is the process you want to improve? What does it consist of? What aspect of it do you want to improve?

2. If you do not fully understand the process and all its parts, it is very difficult to propose improvements.

3. Use different tools, like graphs that help you better understand the process, and methodologies that promote innovation.

4. What measures and controls exist to guarantee the quality of the products or services you offer? Can they improve?

5. Repeat this process as many times as necessary to enable its continuous improvement.

FINAL REMARKS

To achieve incremental or transformational improvements in the example process, the steps and recommendations contained in this pill must be followed. Some examples of possible improvements to this process are:

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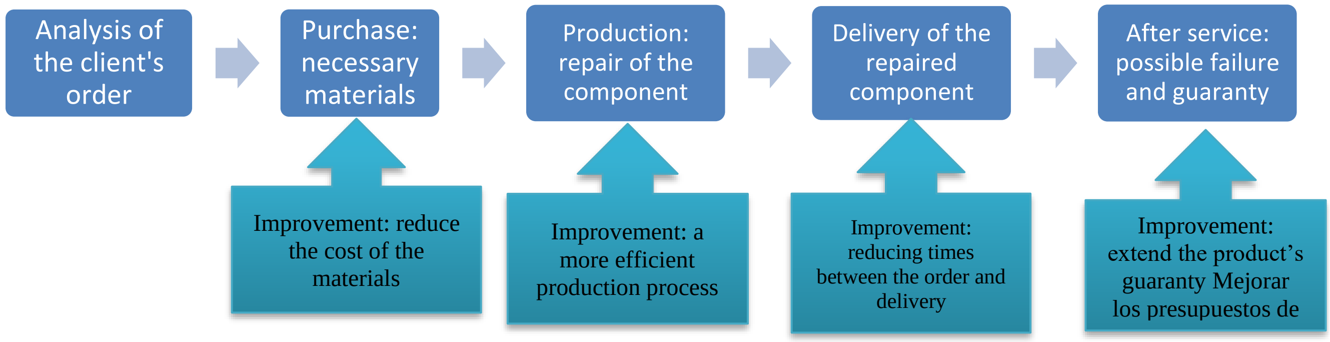
Analysis of the client's order
Purchase: necessary materials
Production: repair of the component
Delivery of the repaired component
After service: possible failure and guaranty
Improvement: reduce the cost of the materials
Improvement: a more efficient production process
Improvement: reducing times between the order and delivery
Improvement: extend the product's guaranty Mejorar los presupuestos de

AREA 2: SKILLS AND ABILITIES REQUIRED BY THE TECHNOLOGY SECTOR
D.U.2 – JOB RESPONSIBILITIES: knowing the job position and the assigned tasks; knowing the level of commitment that is assumed by the employment relationship or employment contract.

PILL 1 – KNOWING THE JOB POSITION AND THE ASSIGNED TASKS

Knowing the job, what is expected from you, and what is going to be asked of you is essential once you have gotten the position and job… but it is also essential before getting it. To face the selection processes (both for an internship or to become part of the staff), it is essential to carefully investigate the job you are applying for beforehand.

Let's see an example: you want to apply for a job at Nanopaint Lda. You should investigate what the company does, its evolution over time, and what the future holds, in order to describe the job that you could opt for.

<table>
<tr><td rowspan="2">HELP</td><td>First define the company itself; make a pure research exercise. You will have to resort to different sources:
Internet and job platforms.
Publications and news related to the sector.
Project platforms to which they have submitted.
People you know who work in or have a relationship with that company.
Even sending an email to the company itself to request information.</td></tr>
<tr><td>Once you have the most relevant information about the company and are able to explain what they do and what projects they develop, do an exercise in imagination: according to the description of the company and their projects, imagine a job that fits your degree and could exist in said company (from administration, to laboratory technician, messenger…). Then, answer the following questions:
Which tasks and duties would the job entail?
What would be the objectives of the position?
What skills would be required? Which of them do I have and which others</td></tr>
</table>

	can I work on?

FINAL REMARKS

As you will later see, one of the main needs that a job requires is the ability to make well-thought decisions, so you will need to carry out a rigorous analysis of the consequences and possibilities (see decision theory – D.U.4, Pill 2). But first it is essential to know in depth the reality of your company and job. You might think that you already know it, but spend some time getting to know all its intricacies and most insignificant aspects; you'll see how important it is.

PILL 2 – KNOWING THE LEVEL OF COMMITMENT ASSUMED BY THE EMPLOYMENT RELATIONSHIP OR EMPLOYMENT CONTRACT

Can you refuse to obey a work order that involves functions other than those for which you have been hired? Look at these examples or think of others before answering.

- Ex.1: a wedding photographer's assistant (Assistant) sometimes must help the waiters to set up the restaurant tables so the photo session is not delayed.

- Ex.2: an optician clerk (2nd Clerk) must clean the windows and mirrors of the store.

<table>
<tr>
<td>HELP</td>
<td>First of all, know what documents your employment relationship is governed by and look at them thoroughly. You should always have read yourself, at least superficially:

- The employment contract (the document you sign to start working).
- The collective agreement your company is governed by (agreement reached between the workers representatives and the employers representatives of regulate the labor rights of a given sector for a given period of time).
- The workers' statute (your state's own document that determines the basic</td>
</tr>
</table>

labor regulations between the company and the worker).

- National and European labor laws.

Of all of them, where do you think this should be specified? And is it?

As you may well have guessed, it should appear in the collective agreement, since the contract is usually too short to define all these issues, and the workers' statute is too generic (it covers all types of jobs).

First look for each of the collective agreements “Collective agreement for the photographic industry, 2017-2020” and "Collective agreement for retail optics commerce sector and attached workshops”. Keep in mind that collective agreements will vary from one country to another and even from region to region. This example deals with a worker from Madrid (Spain).

In each of the collective agreements, look for the epigraph “Classification according to function”, and in it look for the necessary job category (in this case “Assistant” and “2nd Clerk”); the type of functions they can carry out are described there.

For the 1st example:

The operator, without adequate preparation for the categories included in this Agreement or theoretical-practical knowledge of any kind, carries out tasks that require a certain training, responsibility, and special attention for their execution, both intimately linked with the categories of the Agreement, being able to provide services indistinctly in any of the sections of the company, with the limitation of the professional group to which it belongs.

For the 2nd example:

Tasks consisting of carrying out operations that, even when under precise instructions, require adequate professional knowledge and practical skills, and whose responsibility is limited by direct or systematic supervision.

Do you think they should do the tasks?

FINAL REMARKS

Even if you think you really know your job and your functions, you really won't know them nor your exact rights and duties until you take a look at the regulations that govern it. This is the only way to know if you are experiencing a violation of your rights or not.

However, sometimes many issues are not regulated, especially in companies in new and dynamic sectors, like technology. Use common sense and, once again, analyze to what extent the employer is violating your rights or not. This is not easy to decide and you may have doubts; in those cases, resort to experts, like unions.

Analyze the many unions there are, and which one you feel most comfortable with (due to ideology, having acquaintances, a more accessible headquarters…), then find out if there is a union delegate from your union in your company and turn to him. If there were none of your union (or none at all), go to the delegate of your company regardless of which union he/she belongs to, or go directly to the headquarters of the union to make the consultation. They might ask you to become a member, but in most cases they will solve your doubt.

PILL 3 – DOES THE BOSS HAVE THE RIGHT TO DO THIS?

- An employee has missed 2 days due to illness. Since his work has piled up, he has to stay an extra hour each day for a week. He does not want to, although the company is going to pay him.
- A welder works without a protective mask; his employer informs him that it is a serious offense and sanctions him with a 5-day job and salary suspension.
- A worker in a chemical laboratory has been coughing a lot lately. The employer informs her that she must go to the Association the next day to have a full medical examination, to check if she has an allergy to those chemical components.
- An electrician who makes house calls has to send a message every hour informing his company of where he is.
- The employees of a clothing store must show their bag or backpack to the security guard when leaving.
- A ring goes missing in a jewelry store, and the employer searches the bags of his workers and frisks them.
- A worker accidentally broke a tool. A month later, when the supervisor finds out, he tells him that he must pay for it with his own money.

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AREA 2: SKILLS AND ABILITIES REQUIRED BY THE TECHNOLOGY SECTOR
D.U.3 – TEAMWORK: generating a personal disposition and collaboration with others when carrying out activities to achieve common goals, exchanging information, assuming responsibilities, solving the difficulties that arise, and contributing to the collective improvement and development.

PILL 1 – GENERATING A PERSONAL DISPOSITION AND COLLABORATION WITH OTHERS

Although it will not be your function for the moment, put yourself in the role of a CEO of a technology company that is forming an intersectorial work team, with industrial engineers, doctors, and middle degree VET cycle graduates who are going to be in charge of specific tasks of the new project, which must succeed in designing together an innovative system to detect bone regeneration in patients. What would you do to make the team work? Which tools would you implement?

Make a Decalogue of concrete actions to get the team to commit and work together. For example: "1.- Every morning, first thing in the morning we will all have a meeting no more than 1h long where we each will explain what we are doing and our progress to the rest." Once finished, send it to your assigned tutor.

HELP

First, it is essential to understand the difference between *group* and *team*:

1- GROUP: people working together but, without a shared common goal or objectives (in principle).

2- TEAM: a group of people with complementary skills and experiences, committed to a common goal and objectives for which they consider themselves jointly responsible.

It is therefore essential to understand that any group of people who work together is not necessarily a team; only those who understand that they share common objectives and goals, that they need the contribution of everyone regardless of their qualifications or specific knowledge to achieve them, and that the team requires individual and mutual responsibilities.

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The creation of teams is not automatic, it requires time for its members to get to know each other, build trust, establish ties, and for roles to be generated within the team itself.

This Pill specifies that the team has just been formed, and therefore it is in a Preliminary Phase, characterized by being newly created, its members not knowing the rest not what their role will be, if they will be well received… but it is also a time of high motivation and great interest in starting to work.

Team members in this stage tend to be moderately anxious but optimistic about the opportunity to participate in it; to show anxiety and concern about why they are there, what they will have to do, what they will achieve, who their teammates are, and they will require further mentoring from the team leader. Their work is characterized by: medium-low results and a high effort in defining the goals, functions, way of proceeding, etc.

Little by little, other phases will be developed, such as the Adjustment Phase (a more delicate stage; as they realize the magnitude of the task to be carried out, the team members begin to experience discrepancies and negative feelings), the Cohesion Phase (members reconcile their loyalties and they accept the team, the ground rules, their roles in it, and the individuality of their teammates. Emotional conflict is reduced and competition is increased as previous competitive relationships become more cooperative), and the Efficiency Phase (the team has developed the necessary skills and knowledge to work well together and produce the desired results; they no longer depend so much on the leader, and each member assumes responsibilities in the development of the team if necessary; shared leadership is reached). Each of these phases is characterized by:

a) Teamwork in the Adjustment Phase:

- May be disturbed by negative feelings.
- A gradual increase in the performance of tasks and the development of skills is reflected.

b) Teamwork in the Cohesion Phase:

- Increases little by little as understanding and skills develop, and positive feelings between team members increase.

c) Teamwork in the Efficiency Phase:

- Increases thanks to the pride of a job well done and team cohesion.
- It is easier, more efficient, and more satisfying, with a constant increase in skills, knowledge, and confidence.

Here are the 11 tips that Asana (a multinational company with offices in 11 countries founded by Dustin Moskovitz and Justin Rosenstein -directors of Engineering teams at Facebook-) proposes to help you develop a collaborative business culture:

1. Promote collaboration as a value:

It may sound obvious, but it's critical to clearly state that collaboration is important to you and your team. Not all teams value collaboration; some are motivated by competition or individual prowess. Clarify that collaboration is important and establish how you will come to incorporate it.

2. Establish guidelines for communications:

Setting guidelines for how team members should communicate and work together is part of what you can do to develop and promote collaboration. Remember: first, collaboration will not be effortless; it will take time for team members to work together and feel comfortable with each other, and that's okay. But if you sit down and create a communication plan together, everything will be easier.

3. Invite co-creation:

The basic principle of team collaboration is that teams can achieve more together than their members can separately, so one of the best ways to encourage team collaboration is by promoting co-creation. It's not about just telling group members to work together on a project: instead, organize brainstorming sessions, invite discussions, and open the door to discrepancies. Co-creation implies generating ideas together, not wearing oneself down alone in pursuit of some separate goal.

4. Encourage open communication:

Do it honestly; collaboration happens when team members feel they can bring everything they know to their job. Group members should be encouraged to participate, innovate, and communicate. Instead of holding back their opinions or holding back what they feel, they should be able to be themselves and come up with all the great ideas they can think of. Open communication also means that sometimes not everyone will agree, but discrepancies are not a con for team collaboration. In fact, not agreeing all the time (as long as it is respectful) and having open conversations is essential to display excellent team collaboration.

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5. Lead by example:

It is not easy to create a collaborative team if the leader is not. Collaboration starts from the top, so always promote co-creation, encourage open communications, and take time for the team to innovate and collaborate. Encourage team members to contact you if they have questions, or to set up a one-on-one meeting if they want to have a meeting with a little more time.

6. Take time to strengthen ties:

When was the last time your team got together just to chat? Team-building activities are not just to relieve tension, they are also an excellent opportunity to get to know each other better outside of the workplace. What goals does your co-worker have in life? Where is your boss from and how does his/her background affect him/her? What did your new teammate do before entering the current position?

Teams that manage to connect inside and outside of work know each other better, and when tensions arise or the work gets hard, they communicate more easily, manage to bridge gaps and collaborate more efficiently.

7. Highlight good teamwork:

Everyone likes to be recognized for a job they have done well; complimenting team members for a job well done as a group is the same thing. If two teammates are working together to put a new idea into practice or execute a particularly difficult initiative, take the time to praise them.

Ask team members to share their impressions of their experiences, let them tell you what went well or how they collaborated and worked together to achieve their goals. With this opportunity, you not only give them the attention they deserve, but it can also serve as a reference for other colleagues to collaborate with later.

8. Offer counseling opportunities:

Fostering team collaboration is a social skill. In fact, it is a combination of interpersonal and communication skills. Each individual team member can work to improve those skills, but sometimes having an outside perspective can be extremely helpful.

9. Set goals collaboratively:

How do you set goals in your team? Defining objectives is essential for any team; it can help them align on what is important and what needs to be done to achieve it. Goals are often set in a "top-down" orientation, meaning that leaders are the ones who define the goals and the metrics to meet them. This can be useful for the team or the company to achieve a common goal, but it does not offer the team the opportunity to collaborate and innovate on what they can do to reach said goal.

Consider setting hybrid goals where team or company leaders define the primary goal, but other members are also encouraged to define their own key results or KPIs (Key Performance Indicators) for how they will achieve those goals. You can organize workshops or brainstorms on the metrics; if you open the doors for all team members to participate in defining the goals, you can make them more interested in achieving them.

10. Be flexible:

If you lead a collaborative team you must adapt all the time to the different needs and practices of the other colleagues. Don't expect people with different experiences to follow the same processes, instead, acknowledge and support their particular styles; the more flexible your strategy is to implement collaborative work, the easier it will be to participate in the team.

11. Use shared tools:

The best and easiest way for your team to work together is through collaboration with a single shared tool. When you have a single source of referrals, all of your team's work will happen in the same place. Any new update, shared file or extra content will be found without problems. By reducing barriers to working together and collaborating, you empower your team to accomplish more with less effort.

FINAL REMARKS

When you join a new work team you must assume that not everything will be perfect from the beginning, but that with will, predisposition, and adequate confidence you will be able to integrate into a new team without problems. This will be a process that can take time but when it is over you will have managed to turn the gears of teamwork to make it work.

It is also important that you not only do your job well but that you make an effort to promote communication (understand as much as possible of what the rest of the people are doing, listen to them, and participate actively, but always with interesting and proactive contributions), and always comply with the rules of the team, whether they are defined in documents or tacit.

Collaboration at work is the cornerstone of building a great team. Collaborative teams work together to brainstorm new ideas, carry out ambitious projects, and meet their goals. At a minimum, members of a collaborative team accomplish more by working together than they could alone. Depending on your role, team collaboration at work can be a bit different:

- For team leaders, group collaboration can be very helpful in assigning work while enabling those who report to them to shine with their productions, expand their skills, and advance their careers.
- For individual contributors, team collaboration helps them communicate more effectively with the whole team and work together to deliver on more great initiatives.
- For those who collaborate across multiple departments, team collaboration is critical to ensure that work progresses smoothly. Without a clear way of working together and communicating, the team can become isolated and the work can fall apart.

To be successful when working in a team, it is essential that you develop the following values:

- Clarity: in interdisciplinary teams, clarity when communicating is essential. Try to adapt your language to one that is easily and objectively understood. Whether you have very technical knowledge or your language is excessively informal, you must adapt your language so that everyone understands you.
- Efficiency: be efficient (invest the minimum time and costs in achieving excellent results) in all your activities, not only when you carry out your work, but also in meetings, in presentations, etc.
- Positivity: be positive and spread it to the rest of the team. Everything will not always be perfect, but you can help overcome these bumps with a positive attitude.
- Confidence: have confidence in yourself and in the rest of the team members. Don’t talk just for the sake of it, but if you think you know a lot about something, be confident enough to defend your position and provide your unique and particular ideas and skills.
- Responsibility: take only on what you can really carry out, but once you have, make sure you achieve it. If you need help, ask for it, but never stop doing your job.

A diverse team can strengthen the execution of a project. It is extremely helpful to have different skill levels and personalities, but good collaboration is only possible when all team members truly embody these values.

PILL 2 – ASSUMING RESPONSIBILITIES

You are collaborating in the realization of an assembly in a PLA polymer (a biodegradable thermoplastic that can be implemented in the human body) that is going to be inserted into an animal test subject (a sheep) to analyze to what extent it helps the regeneration of the bone surface of one of its legs.

The assembly is very simple and only requires to put three pieces together, one inside the other, so that later the doctors can insert it. The pieces have been printed in the operating room itself, weighing just over 250g in total (due to support material and structures) and it is in this room that you put the three pieces together.

The costs of this test are over 35000€ and it has taken more than a year to get all the permits. NOT being able to carry out the trial successfully would entail serious costs for the company (even if it were repeated, the trial subjects and their derived costs would be lost), and possibly the research project wouldn't go ahead, losing a real way of giving a chance for many people to walk again.

When you proceed to assemble the part… the pieces do not fit perfectly; one wall of the pieces is some microns (1000 smaller than a millimeter) bigger than it should. What are would you do?

1. State that the pieces do not fit and inform your superior to cancel the project.
2. Print the pieces again.
3. Take a small file that you carry in your pocket and, although it was not planned, fix the problem.

<table>
<tr><td rowspan="2">HELP</td><td>What does a biosanitary trial entail?</td></tr>
<tr><td>Do you know how much it costs?

The biosanitary material is very expensive, the PLA polymer from a trustworthy company with accredited constant and defined characteristics, created through repeatable and trustworthy processes, can cost more than 25€/g. Adding taxes and transport, the price can increase up to 30€/g (Shenzhen Esun Industrial Co. Ltd., prices – 2021).

Bear in mind that this material is designed to be the body of a human being and is fundamental.</td></tr>
</table>

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FINAL REMARKS

Assuming responsibility is something necessary and positive, as long as it is coupled with a realistic and objective analysis of both your own abilities and the consequences of your actions. This analysis has to be meticulous, and requires an exhaustive knowledge of what you are doing and all the processes linked to it, to really know if making these decisions actually does help in the work or if it generates even bigger problems. If you are not in the position to analyze all the consequences… you better not risk it. It is the responsibility of others to make those risky decisions.

In the case above, for example, printing the piece again might seem like a smart thing to do, but isn't. If there is a measurement error, even if you print it again, the error will still be there, because it is likely a design problem, so you'd have made the company spend another 7500€ in a piece that will not work.

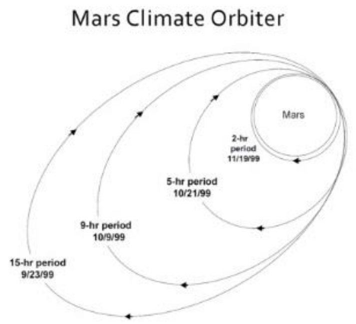
If you choose to fix it, you would be making a terrible mistake: as much as you think your file is clean, it certainly is not to the level required, and can cause infections in the test subject. Also, filing can cause PLA particles to dislodge inside the test subject causing severe medical problems. Lastly, when filing by hand, the joints of the piece will not be perfect and the test will not have repeatable results either.

PILL 3 – SOLVING THE DIFFICULTIES THAT MAY ARISE AND CONTRIBUTING TO IMPROVEMENT AND COLLECTIVE DEVELOPMENT

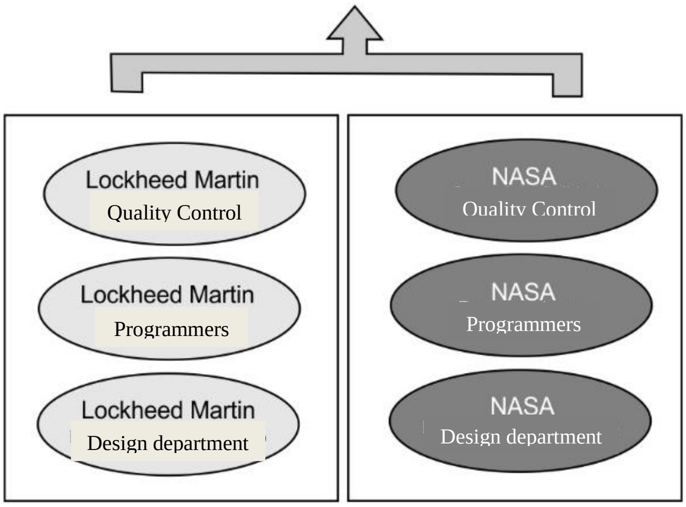
The Mars Climate Orbiter (MCO) was a NASA probe launched from Cape Canaveral on December 11th 1998 by a Delta II 7425 rocket, and reached Mars on September 23rd 1999, after a journey of 9 and a half months. This mission was previously named Mars Surveyor '98 Orbiter.

With everything ready to celebrate the success of the mission, the 125 million US dollars probe hid behind the planet and never came out again, they lost control of the device and it ended up crashing on Mars. Look online for the exact failure of the satellite and its cause.

The following is the structure of the work teams that developed the orbital positioning system. Organize the previous work teams in a way that problem could have been avoided.



SATELLITE ORBITAL POSITIONING SYSTEM



Software for the theoretical calculation of the positioning for the height of the orbital insertion of the satellite.

Software for the detection of the real positioning for the height of the orbital insertion of the satellite.

HELP

On November 10th 1999, the Mars Climate Orbiter Accident Investigation Board released a Phase I report detailing the plausible issues encountered in the loss of the spacecraft. Previously, on September 8th 1999, the Trajectory Correction Maneuver-4 (TCM-4) was calculated and then executed on September 15th, with the objective of placing the spacecraft in an optimal position for an insertion maneuver that would bring it around Mars to an altitude of 226 km (140 miles) on September 23rd.

However, during the week between TCM-4 and the orbit insertion maneuver,

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	the navigation team indicated that the altitude might be much lower than anticipated (at 150-170km). 24h hours before orbital insertion, calculations placed the Orbiter at an altitude of 110km, when 80km was the minimum altitude that Mars Climate Orbiter was thought to be able to survive this maneuver. Post-failure calculations showed that the spacecraft was on a trajectory that would have brought it within 57km of the surface, where it likely violently jumped into the upper atmosphere and was either disintegrated or re-entered heliocentric space. The primary cause of this discrepancy was that ground software provided by Lockheed Martin produced results on a US customary unit, contrary to its Software Interface Specification (SIS), while a second system, supplied by NASA, expected the results to be IS units, according to the SIS. Specifically, the total impulse produced by thrusters was calculated by software in pound-force seconds (lbf-s). The trajectory calculation software used these results to update the spacecraft's predicted position, expecting them to be in newtons per second (askew by a factor of 4,45). Still, NASA does not hold Lockheed responsible for the loss of the mission; instead, NASA officials state that NASA itself was at fault for not performing the proper checks and tests that would have detected the discrepancy. The difference between the calculated and measured position, resulting in the discrepancy between the desired and actual orbit insertion altitude, had previously been noticed by at least two navigators, whose concerns were dismissed because “they didn’t follow the proper rules on how to fill the form to document their concerns”. A meeting of trajectory software engineers, trajectory software operators (navigators), propulsion engineers, and managers was called to consider the possibility of executing the Trajectory Correction Maneuver-5, which was on schedule. Meeting attendees recall an agreement to make TCM-5, but ultimately it was not done.
	All technological development -especially that developed by multidisciplinary work teams- requires exhaustive quality control and continuous information exchange to avoid serious issues. Although there are many quality systems for development processes carried out by work teams, we recommend that you look online for the QFD system and apply it to this result.

FINAL REMARKS

Teamwork implies that the objectives of each individual cease to be priority, and the success of the final work -developed through the collaborative action of all members- is what matters most. This means that a group is more than the sum of its parts; it is the interaction between them, the ideas that arise from collaboration and different points of view which lead to achieving the proposed objectives.

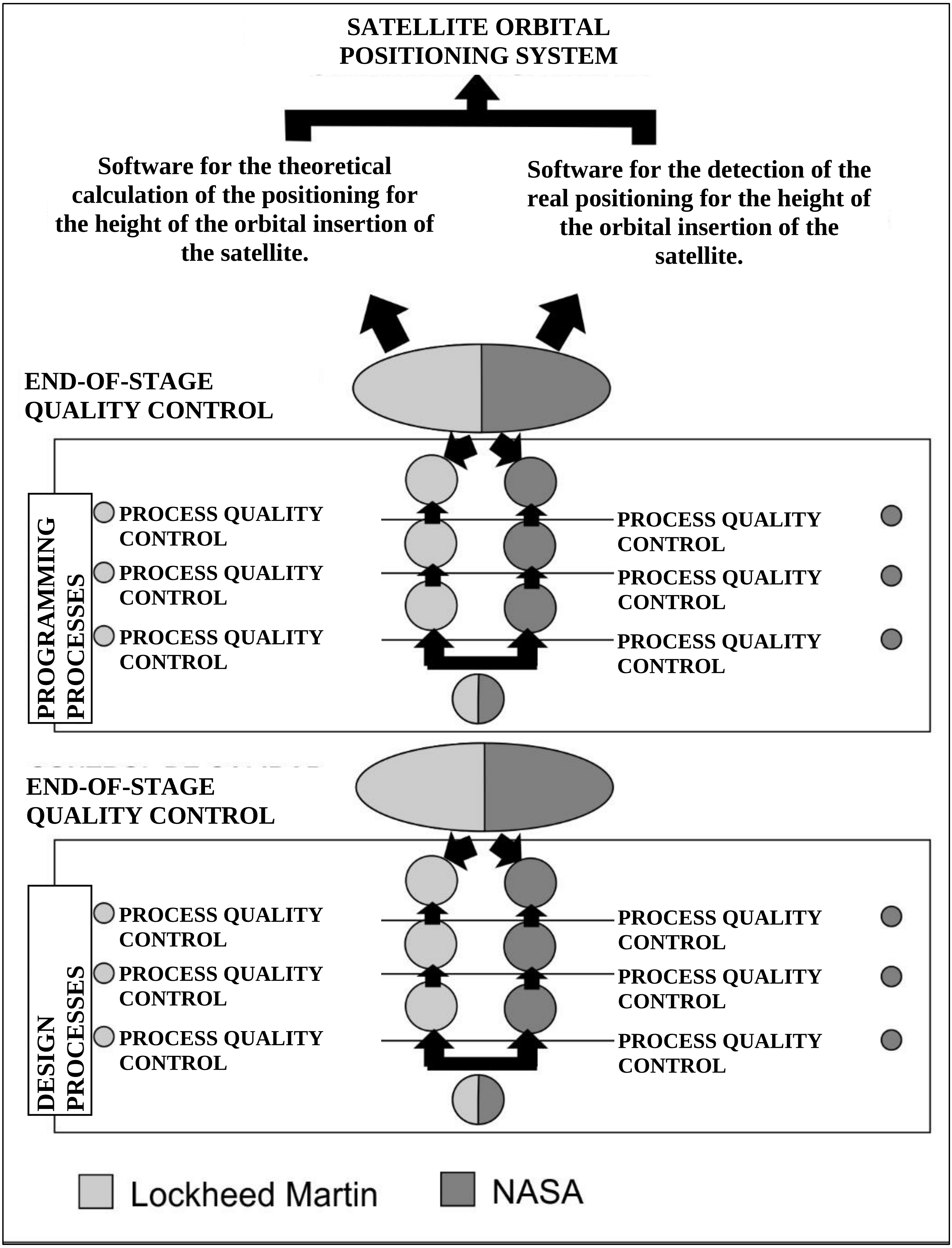
However, this is not as simple as it seems, especially in interdisciplinary teams, where each of the members is an expert in one area but perhaps not so much in others. It is common to fall into the inertia of distributing the tasks consistently with the knowledge of each member and creating isolated areas where each individual does autonomously what he/she is best at. This usually leads inexorably to mistakes that jeopardize the whole project, and can entail serious costs for the company, especially for technology companies developing long and complex innovative projects. To prevent this from happening, it is essential that:

1.- Each member of the team tries to understand the process as a whole and what their teammates do. This does not have to be a deep knowledge, but they have to be able to analyze the *what*, *why*, and *how* their work is carried out.

2.- Spaces for joint work must be created, but also spaces for the exchange of expressions and knowledge (meetings, workshops, sessions…) where everyone can freely and respectfully express their doubts to be solved by the group or reconsider the project.

3.- Every group member is a co-participant in its success or failure, so it is essential that all take responsibility in looking for mistakes or errors of any other, with the objective of helping them solve it.

4.- Quality control is paramount. External observers must be created to monitor what is being done. The work of the group must be planned in small processes to be checked and analyzed separately, but also its interaction with the previous work.


SATELLITE ORBITAL POSITIONING SYSTEM
Software for the theoretical calculation of the positioning for the height of the orbital insertion of the satellite.
Software for the detection of the real positioning for the height of the orbital insertion of the satellite.
END-OF-STAGE QUALITY CONTROL
PROGRAMMING PROCESSES
PROCESS QUALITY CONTROL
PROCESS QUALITY CONTROL
PROCESS QUALITY CONTROL
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PROCESS QUALITY CONTROL
END-OF-STAGE QUALITY CONTROL
DESIGN PROCESSES
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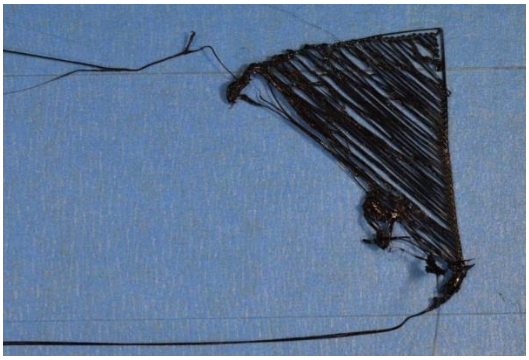
Lockheed Martin
NASA

AREA 2: SKILLS AND ABILITIES REQUIRED BY THE TECHNOLOGY SECTOR
D.U.4 – INITIATIVE: acting autonomously; the ability to choose with your own criteria; to carry out projects and actions necessary to develop options and plans in the workplace.

PILL 1 – ACTING AUTONOMOUSLY

You have been asked to design and print a piece on a FFF (Fused Filament Fabrication) 3D-printer for a prototype that your company is creating in a material called ABS (one of the most common). The piece has a non-complex shape like the one shown in the image. It should be easy, but when trying to print the first layer, the thread doesn't attach to the base.



It is not your responsibility, because these errors must be solved by the person responsible for it in the work team… but you want to find out why. Can you tell why this happens?

HELP	We start from the (maybe wrong) assumption that you don't know how a 3D-printer works, nor how to solve this problem, but this exercise is just about that, you having the autonomy to first learn on your own about something you don't know, and then knowing how to look for answers that explain the problem. Doing the second without 3D-printing notions is not advisable. For this reason, the first thing you should look for online is a simple guide on how a 3D-printer works. There is very interesting information regarding the Prusa, a pioneering royalty-free printer. Note that not all 3D-printers are the same or print in the same way; look for the system that matches the statement.

	The mistake in this Pill is common, and is not directly linked to the material (ABS). If you have understood how a 3D-printer prints, you should have a hypothesis (an unconfirmed theory, a first idea that might or not be true) about why this happens; then, try is to confirm it. If you have a 3D-printer, we would recommend you to do tests to confirm your hypothesis, but since that might not be the case (or you would have solved this exercise immediately) we recommend that you look online for "common 3D-printing problems and solutions" to find out if your hypothesis is correct.
	This type of 3D-printing is based on depositing on a platform (the "bed") that can be heated a thread of molten material from a duct (with an end nozzle attached to a head at very high temperature) at a certain height of the bed. When you design a piece (model), a software segments the it into many layers (from just 0,1mm thick), and to print it, the machine "draws" each of the sheets on the bed while it presses the material deposited with the nozzle so it sticks to the bed. When finished, the nozzle and head rise a bit and print the next layer on top of the previous one. Repeating this process generates the 3D piece. But in our case, the thread does not stick to the bed. The most probable causes are either that the nozzle is too high and therefore does not press the printing material to the bed, so it doesn't stick to it, or that the speed with which the nozzle moves is too high, so it doesn't have time to stick either.

FINAL REMARKS

Autonomy in technology companies is a complex matter, as it must be enough to overcome problems and barriers so that you do what you have been asked to, but it must not be excessive, as it can cause serious problems for the company and your work team. You will often not be able to foresee the real consequences of your actions, because you still won't have enough experience to do so.

As a general rule, autonomy must have the following premises:

- Develop your analytical skills and know what you are doing as much as you can. This way, you'll better determine the consequences of your actions.

- Autonomy should allow you to overcome the barriers you find to the problems that arise when carrying out what has been asked of you.

- Autonomy should lead to a self-learning process that encourages problem solving and enhances your skills. It may require occasional help from a peer, and always from a manager, but it does not have to be a guided process.

PILL 2 – THE ABILITY TO CHOOSE WITH YOUR OWN CRITERIA

A company buys raw materials from two suppliers (A and B), whose quality is shown in the following table:

	SUPPLIER A	SUPPLIER B
Cost of 1000 pieces	4000€	3500€
1% of the pieces is defective	80%	50%
2% of the pieces is defective	10%	40%

The orders placed by the company amount to 1000 pieces, and a defective piece can be repaired for 100€. Although, as indicated in the table, the quality of supplier B is lower, they are willing to sell 1000 pieces for 500€ less than supplier A. Which supplier would you choose?

HELP

To solve this exercise, which is not easy, all you have to do is analyze each of the options and their consequences in detail. For it:

1. Define the decision, meaning the options you have.
2. Define the alternatives offered by each of them (% of defective parts).
3. Create the decision tree, a tree diagram that includes every alternative.
4. Assign the probability of error for each of the branches of the diagram according to the previous table.
5. If you are going to buy 1000 pieces, calculate in each case how many of them are going to be defective and how much it is going to cost to repair each one (100€ each). To do this, just multiply the number of pieces by the probability of being defective and by the price of repairing each one.
6. This is the most difficult step; since each option has a different probability, you have to calculate the *mathematical expectation*, also called expected value, which is the mean value of a set of data. To do this, multiply the probability of each path by the cost of said path, and add it to the cost of the rest of the paths of each provider.
7. Now you just have to calculate the total cost of the operation, meaning to add the price of the pieces to the costs of repairing the defective ones.

Download the PROBLEM SOLVING SUBJECT offered by University of León for free, and take a look at UNIT 3. https://servicios.unileon.es/formacion-pdi/files/2013/03/TOMA-DE-DECISIONES-2014.pdf

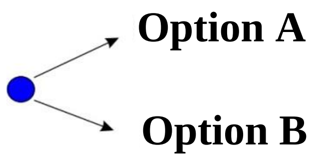
FINAL REMARKS

Making decisions with our own criteria is not easy, and we often do so driven by impulse rather than as a consequence of a rigorous analysis. This can lead to bad consequences even when the decision seems clear.

The way in which decisions are made in a company is based mainly on an exhaustive knowledge of the strengths that it has, but above all, on analyzing the possible consequences of each available option. Once you know each outcome with an adequate degree of certainty, choosing the best option is simple. If you don't have enough certainty, look for more data or assume that you can't make an adequate decision.

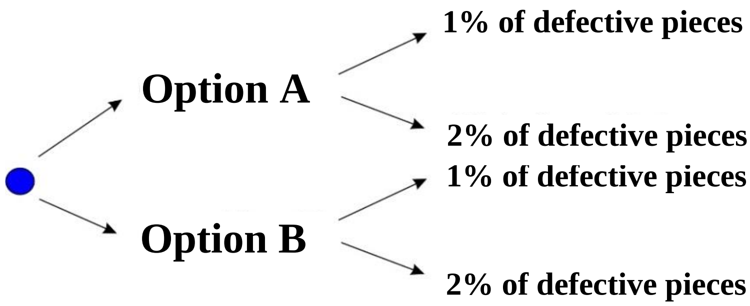
Solving this exercise implies following these steps:

1.- You have 2 options:

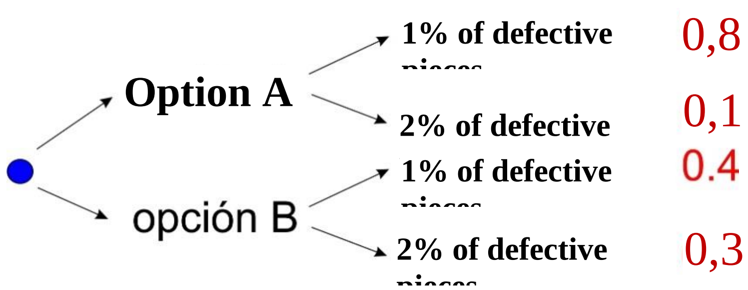


2.- The ramifications of each of the options are that either 1% or 2% of pieces are defective.

3.- The option diagram is:



4.- Assign the probability of defective pieces for each branch.



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5.- If we are going to buy 1000 pieces, we have to calculate how many will be defective in each case:

- 1% of 1000 pieces in option A are 10 pieces, so if repairing a defective piece costs 100€, the cost of repairing all of them is 1000€.
- 2% of 1000 pieces in option A are 10 pieces, so if repairing a defective piece costs 100€, the cost of repairing all of them is 2000€.
- For option B, the repair costs of 1% and 2% of pieces are still 1000 and 2000€.

6.- This is the most difficult step; since each option has a different probability, you have to calculate the expected value, the mean value of a set of data.

- Supplier A: (1000*0,8) + (2000*0,1) = 1000€
- Supplier B: (1000*0,5) + (2000*0,4) = 1300€

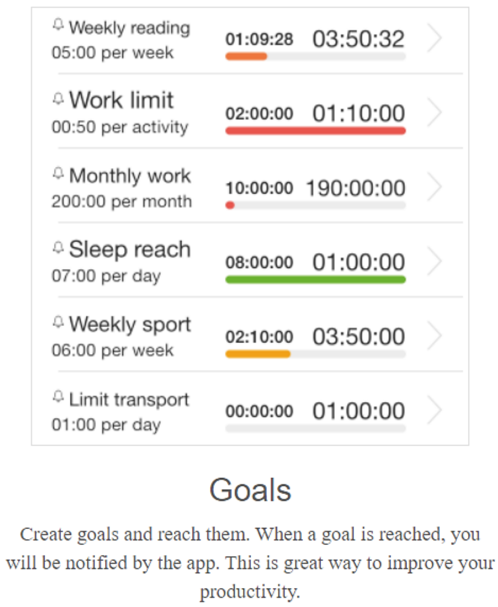
7. - Now calculate the total cost of the operation, meaning the cost of buying all 1000 pieces plus the cost of repairing those that will be defective:

- Supplier A: 4000€ + 1000€ = 5000€
- Supplier B: 3500€ + 1300 = 4800€

So the most logical option is to buy from supplier B.

PILL 3 – PROJECTS AND ACTIONS NECESSARY TO DEVELOP OPTIONS AND PLANS IN THE LABOR SPHERE

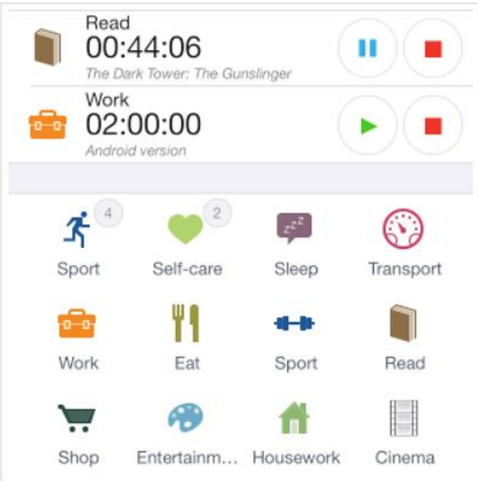
In a job, especially if it is demanding like the one you'd have in a technology company, it is essential that you know how to organize your time and are able to carry out the actions for the activities requested within the required period. But this is not easy and requires specific learning; to do this, use the APP *ATimeLogger* on your smartphone (there are many other specific APPs that you can use in the future):



1.- Download the *ATimeLogger* APP.

2.- Analyze all your daily activities and estimate the time you should dedicate to them.

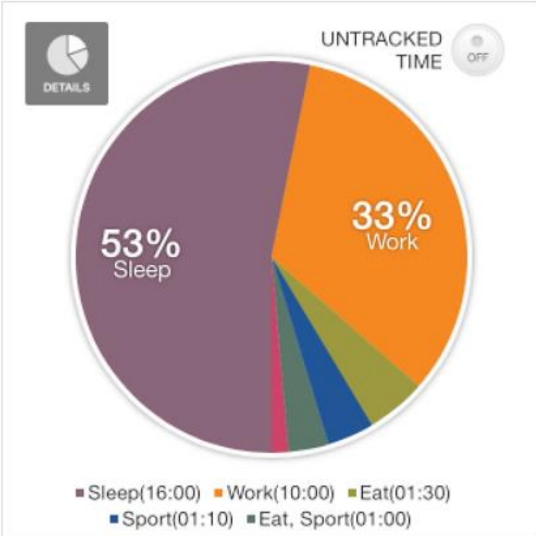
3.- Select the bell icon on the initial screen and enter this list of activities.



Track with ease

Start tracking an activity with a single tap! Simply opening the app and tap on the appropriate activity type icon. When you wish to stop or pause the activity, tap on the stop or pause icon.

4.- Throughout the next day, select which activities you do and specify the actual time you spend on them.



Visualize data

Statistics are available in form of bar or pie chart. Everybody likes charts!

At the end of the day, compare the proposed objectives with reality and look at the results in the pie chart.

Did you make a good estimation of objectives compared with what you have actually done? How could you have done it better?

HELP	Analyze first the type of activities you have done, and if they really depend on you or not. If they don’t (like time spent in the bus), analyze not just the time spent on that task in one day, but several weeks, and extract the median. That will be a good point to plan the actual time spent in the task. If they depend on your actions, think about what happened that made you take longer than expected. Did you miscalculate or you invest time wrong? Did you spend the time of that task in do others?
	One of the key aspects to plan your time and achieve your proposed objectives is to know the most common mistakes that facilitate the loss of time. Knowing them will make it easier for you to avoid falling into them, being more effective in your job, or in your day-to-day. For many authors, the most common risks

	are: 1. A lack of objectives: we often know what has to be done, but we don't establish coherent objectives for it. Doing this makes very difficult to give each task the necessary importance and order. 2. Misuse of tools: process and time control software are currently very common tools for organizing the different tasks that comprise a project or activity, but it is not always easy to use them, and they may cause more problems than the ones they fix. One of the most common the need to use several software simultaneously (Google Drive, iCal, Doodle, Calendar, Evernote, Toggle, Teamviewer…), which can lead to distraction. 3. The inability to prioritize tasks: when not all important tasks are carried out, it is because priority is given to those that are more comfortable or easy. To avoid this, you can create a list every morning by urgency or importance, and avoid multitasking. 4. Poor planning: many times we start with what we like the most or what is least difficult for us, without having planned the tasks as a whole, meaning that we leave the most complex things for last without leaving enough time to carry them out. By structuring the work, no unforeseen event will prevent the objective from being achieved. 5. Ineffective communication: communication must be simple, direct, and without ramblings. In a meeting, it is important to focus on its objective, to waste less time. To do this, carry out a good planning beforehand.

FINAL REMARKS

Time planning, both in your personal life and in your work schedule, is absolutely essential. Not only because it will allow you to perform better during your day, but because it will give you a real vision of the tasks that you are capable of assuming and which ones you are not.

One of the most common mistakes when we start a new job is thinking that we are capable of taking on many more responsibilities and tasks than we really are, especially in a new environment. This usually ends up in frustrated expectations and the inability to deliver the commissioned work in time or, if you do, in the quality of said work not being what was expected… and that is a great setback that can seriously harm your company.

It is essential to analyze what you are really capable of doing (without taking on more than you can do or less than you can give) and to do what you take on in time and with the proper quality. Next, we suggest some strategies that can help you:

1. The urgency/importance duality.

It is important to differentiate urgent tasks -those that must be prioritized, carried out immediately, but dedicating less time to them- from important ones, which can be done later but with more time dedication.

2. Create a daily plan.

At the beginning of your day, spend a little time planning it, defining the tasks that you know you have to do, and estimating the time it will take. You also need to leave some free time for unforeseen events or urgent unplanned tasks, since if they end up not being an issue, you can spend it on continuing the important tasks. To do this, it is important to use digital tools like Google Calendar (to schedule the tasks that are up to date) or Freemind (to generate diagrams of linked tasks), among others.

3. Set time limits for tasks.

A task like reading and answering emails could take you all day if you don't set a time limit for it. Thus, we recommend establishing, for example, blocks of 15 minutes every three hours to check the email inbox. This strategy of limiting time can be applied to different tasks, and in this way you can avoid the feeling that something specific always absorbs most of the working day.

4. Order and organize your environment.

A messy environment causes a lack of concentration and forces you to spend more time than necessary on minor tasks. If you spend five minutes looking for the stapler you are wasting precious time that you can spend on important tasks… and if this happens often, it is becoming a significant time waster. Keep your table and work environment orderly and organized, without piles of papers or useless items that absorb your attention.

5. Don't try to do several things at once.

It is usually much more effective that to focus on just one task and not several at the same time; if you analyze it you will notice that the time spent doing two things at the same time is not significantly less than the time spent doing them one after the other, but the risk of doing them wrong is significantly higher.

6. Don't procrastinate.

If you find yourself procrastinating or making excuses for not doing something, ask yourself why. Procrastination is one of the main enemies of proper time management and it often causes you to feel overwhelmed at the end of the day by all those tasks that you have been postponing and that end up accumulating.

7. Dedicate yourself to work only at work; dedicate to enjoy in your free time.

Using social networks, WhatsApp, and personal email might seem less time than it really is, but these can make us spend up to three hours of our time each day.

AREA 2: SKILLS AND ABILITIES REQUIRED BY THE TECHNOLOGY SECTOR
D.U.5 – INNOVATION: developing the ability to carry out a systematic search for opportunities and solutions to problems through different ways of thinking and acting, materializing in new products and services that meet the needs analyzed.

PILL 1 – INNOVATION

Innovation is a key competence, highly demanded in organizations in all sectors, but especially for companies in the technology sector, since the ability to systematically search for opportunities and solve problems through different ways of thinking and acting is key to the development of this sector.

Describe in your own words what innovation in the workplace is for you, and give an example of it.

HELP

Workplace innovation consists of the deliberate application of information, imagination, and initiative to derive greater or different values from resources, and includes all the processes by which new ideas are generated and turned into useful products. In business, innovation often occurs when ideas are applied by the company to further meet customer needs and expectations. We can divide innovation into two large groups:

- Evolutionary innovation: (continuous or dynamic innovation) caused by many incremental advances in techniques or processes; it is produced gradually over time, modifying the processes with small improvements that accumulate and enhance innovation.

- Breakthrough innovation: (discontinuous innovation) often disruptive and new; it is completely innovative and represents a radical change in the processes that were previously carried out.

Although innovation can arise spontaneously in most companies, innovation is promoted through a structured and specific process (the innovation process) that can be divided into 4 main stages:

a) Idea: collection of innovation potentials, derivation of ideas, evaluation, and release of ideas.

	b) Concept: extensive analysis and derivation of concepts for the solution, implementation, and commercialization. c) Solution: development and testing of solutions to the finished product. d) Market: arouse and satisfy the needs of customers through implementation in purchasing, production, logistics, marketing, and sales.
	Innovation in the workplace or business can take two different forms: ▪ Innovation as a process by which an idea is transformed into a new product or service on the market, or by which new manufacturing processes or organization or marketing methods are incorporated into the company (innovation capability of the company). ▪ Innovation as the activity by which results derived from research and development (knowledge, prototypes) are launched onto the market by way of new products or services, or are turned into new processes in the company (R+D+I). Lastly, innovation, like any business process, can be managed and controlled, this being the maximum exponent of awareness and control over innovation. There are various situations in which companies are aware that they innovate but without having control over it, so they generally innovate occasionally, or maybe more commonly but just when driven by customer or market demands, without anticipating said demands.

FINAL REMARKS

You should know the definition of the competence of creativity and innovation, understood in the field of organizational psychology as “the ability to carry out a systematic search for opportunities and solutions to problems through different ways of thinking and acting, which usually materializes in new products and services that meet the needs of a given target audience”.

Developing the key competence of creativity and innovation in adult students is one of the main objectives of Didactic Unit 5 of this course.

PILL 2 – SATISFYING NEEDS

Once we have defined what innovation is, along with the main types of innovation and the stages of its process, you are going to study how to make innovative ideas materialize in new products and services that satisfy analyzed needs.

Starting from the example of innovation that you proposed in the previous pill, explain how it can materialize in new products and services that satisfy needs.

HELP

Here are the 5 main tools to develop innovation:

1. Design Thinking: this methodology places the user in the highlight, to empathize with him/her and discover his/her needs. This shift in our way of thinking allows to detect opportunities where before there were only problems, thus finding innovative solutions and allowing to improve products and offer new ones. This methodology is divided into 5 stages:

a) Empathize.
b) Define.
c) Devise.
d) Prototype.
e) Evaluate.

It is an ideal tool for teamwork, because it connects different specialists throughout the process who provide their different points of view.

2. The blue ocean: destructive actions are often carried out between competing companies. W.Chan Kim formulates in his book “The Blue Ocean Strategy” the need to put aside these battles and focus on creating value through innovation. Blue oceans represent still unknown business ideas, and are based on:

- The discovery of market territories still without competition.
- Seeing competitors as irrelevant.
- Attracting new customer niches.
- Understanding that being the cheapest is not enough.
- Focusing all efforts on achieving differentiation.

While red oceans represent today’s competitive markets, accepted as they are, most blue oceans are born from red oceans by expanding existing businesses.

3. Lean Startup: the Lean Startup methodology reduces the risk involved in launching an innovative product by allowing to check different aspects of a given future business at low cost in the real market:

- If there is a real problem that needs a solution.
- If the proposed solution is interesting for the target audience.

- If customers will really be willing to pay for it.
- If sales are going to be generated on a recurring basis.

In short, this methodology allows to carry out a trial-and-error system without having high costs.

4. Business Model Canvas: if what you need is to capture your business model on a single sheet and understand the company as a whole, this methodology is the best. The 9 blocks that compose it are:

a) Customer segments.
b) The value proposition.
c) The channel.
d) The relationship.
e) Income flows.
f) Key resources.
g) Key activities.
h) Alliances.
i) The cost structure.

But using this tool is not just about drawing on the canvas, it will help you think strategically and understand how the different blocks that comprise it are interrelated. Therefore, its benefits are important, since it increases your observation capability while providing varied approaches.

5. The keys of thinking: the first step to carry out an innovation process is to have ideas, which is not usually an easy task. Tony Ryan discusses how to create effective thinking routines with the help of 20 keys that "open" thinking to creativity. These keys are metaphors for the strategies followed to carry out critical and creative thinking:

- The question.
- The reverse.
- Brainstorming.
- The different uses.
- The constructions.
- The inventions.
- Forced relationships.
- The disadvantages.
- The alternatives.
- The combination.
- The alphabet.
- The picture.
- Ridicule.
- The what if?

- The M.A.C.
- The interpretations.
- The usual.
- The brick wall.
- The prediction.
- Variations.

As explained above, the first step in an innovation process is to have an idea, but it is also essential to know how it will materialize in new products and services that meet the needs detected. To achieve this goal and turn an idea into an innovation blueprint, in addition to using the 5 tools described in “Help 1”, the following questions can also be used as a guide:

- Is the new product or service consistent with the company’s future strategy?
- Is this new idea aimed at known customers?
- Does it target new geographic markets?
- Is the technology needed to develop the new product, service, or process known?
- Do we have enough resources to develop this innovation project?
- Is it essential to make an alliance with another company to develop it?

Answering *no* to all or some of the questions does not mean that we should not do the project. The purpose of these key questions is to compare projects which ones are the best for the company’s strategy, and to estimate the chances of success in developing the project. Some examples are described below to help you know what is innovation and what isn’t:

a) The development of the prototype of a car fueled by water.
This is technological innovation, since developing a new car with an unusual fuel means meeting a high technological challenge.

b) The start of a new process that reduces manufacturing time by 40% in the production plant of a technology company.
It is not technological innovation if just new equipment has been purchased and installed on the production line; it is considered an investment. It is technological innovation if the development of the new process was a technological challenge and was designed by the company.
c) Applying a new marketing strategy that increases sales by 20%.
It is not technological innovation, since it doesn’t imply a technical challenge, but redefining the company’s sales strategy is a conceptual innovation.

FINAL REMARKS

Environmental innovation or Eco-innovation is currently very relevant in practically all companies, so it is essential to take this area of innovation into account.

The environmental innovation criteria can also be applied to the company's management systems, covering aspects like defining waste treatment systems, product design criteria, negotiating relationships with suppliers, developing new skills in human resources, the strategic definition of the company's technology and its production processes, or the development of new relationships with customers.

AREA 3

BASIC TECHNOLOGICAL TRAINING FOR EMPLOYABILITY

AREA 3: BASIC TECHNOLOGICAL TRAINING FOR EMPLOYABILITY
D.U.1 – SCIENTIFIC AND TECHNOLOGICAL KNOWLEDGE: acquiring the basic scientific and technological knowledge necessary to effectively carry out a job in innovative companies.

PILL 1 – DIMENSIONS

You are trying to make a one micron (1µm) thick coating on a metal surface. Perhaps the first step is to understand how big a micron is: try to envision a physical image of its size and explain it in a few lines. That explanation can have two parts, first the definition of the micron itself -but that definition probably does not provide an intuitive mental image of its size-, so then it might be worth looking for examples of real things with sizes closer to the micron or perhaps of a few microns.

HELP	The micron or micrometer is one thousandth of a millimeter or one millionth of a meter. 1µm = 0,001mm = 0,000001m, or in scientific notation: 1µm = 10^{-3}mm = 10^{-5}m. Review scientific notation if you need to, to be sure that you understand it, but these numbers are hardly intuitive anyway.
	As a reference, you could cite the smallest size the human eye can see: you can easily find that the minimum difference that the human eye sees is around the order of 80µm, so around the diameter of a hair.
	The order of magnitude of microns or ten microns is already considered for microscopic objects. Most bacteria have sizes between 0,6 and 1µm, so they must be watched under a microscope; other cells are somewhat larger in size, like white blood cells being about 25µm, so optical microscopes are enough to see them. Viruses are smaller and must be observed with more powerful microscopes, like electron microscopes.

FINAL REMARKS

The finest coatings made on surfaces are of molecular size thicknesses, with molecules grafted onto the surface in a monolayer. That thickness could be the size of up to a few nanometers (nm) if what is grafted are macromolecules or polymers. The nanometer is one thousandth of a micron (0,001µm); the length of molecular bonds is in the order of a tenth of a nanometer (0,1nm). There are various techniques for making coatings on metals, such as electrochemical deposition, chrome plating, anodizing, paints or lacquers. If you are curious, you can find the thickness of the layer that covers the material in each case.

PILL 2 – VISCOSITY

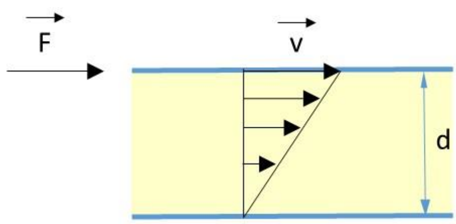
Viscosity is a physical property of fluids on the one hand intuitive and on the other involving concepts that are difficult to understand. It is related to the resistance a liquid or gas has to flow through a conduit or on a surface. The difference between a more or less viscous fluid can be seen simply by pouring it slowly into a container. For example, water is a low viscosity fluid, so when it is poured into a glass, it moves across the bottom quickly to form a layer. Oil at room temperature has a higher viscosity, and honey is even higher: you can easily see how long it takes to slide across the bottom of the glass.

It is more difficult to understand the physical origin of this property and its precise definition: it has to do with internal friction within the fluid. Imagine the fluid separated into layers, so that when some layers slide over others it is necessary to exert a force with a value depending on the interaction between the molecules of the fluid.

Look online or in other sources for the concept of dynamic viscosity, its precise definition, and try to explain it in your own words. Look for in which units it is measured and the value it has in some characteristic fluids.

HELP

You will have probably found a diagram similar to this one, showing a fluid layer enclosed between two surfaces whose area is A, the lower one in a fixed position, and the upper one free to move. For the upper surface to slide, force must be applied, which will be the greater the more viscous the fluid.



The force per unit area is F/A. The upper surface slides at speed v, and the lower layer at 0 speed. In the simplest behavior, which follows Newton's laws, the speed in the intermediate layers of the fluid varies linearly, depending on their distance to the lower layer, between 0 and v. Thus, dynamic viscosity is defined as:

$$\eta = \frac{F/A}{v/d}$$

Therefore, as said in the previous paragraph, the higher the viscosity of the fluid, the greater the force that must be applied to make the upper layer move at a given speed.

$$\frac{F}{A} = \eta \frac{v}{d}$$

The International System (IS) unit of force is Newton (N), meter (m) for distance, square meter (m^2) for surface, and speed is measured in meters per second (m/s). Therefore, the unit of dynamic viscosity is the $N \cdot s/m^2$, or Pascal per second (Pa·s), since Pascal is the unit for pressure ($1Pa = 1N/m^2$).

We should use IS units universally to avoid errors, but that should not prevent you from being able to understand data published in other units. You will also find the "Poise" as the unit for dynamic viscosity. What is it? How is it related to the IS units? 1P = 0,1Pa·s

Here are some specific example values of viscosity of common fluids:

Fluid	η ($N \cdot s/m^2$)
Air at 20ºC	$1{,}8 \cdot 10^{-5}$
Fuel at 20ºC	$2{,}9 \cdot 10^{-4}$
Water at 20ºC	$1{,}01 \cdot 10^{-3}$
Mercury at 20ºC	$1{,}55 \cdot 10^{-3}$
Human blood at 37ºC	$4{,}0 \cdot 10^{-3}$
Glycerin at 20ºC	1,5
Honey at 25 ºC	Between 2 and 40, depending on type and moisture content.

There is a great difference between the dynamic viscosity of fluids that appear to be very viscous and those we appreciate as very fluid; honey for example has a viscosity thousands of times greater than water at the same temperature.

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FINAL REMARKS

Viscosity depends on external variables, especially temperature. For example, water has a viscosity of approximately 1Pa·s at 25ºC, but it would have more or less half that at 55ºC. Perhaps one cannot appreciate this difference in water so much, but in cooking oil, the change in viscosity can be clearly appreciated when it is heated, and even more so with honey, which almost does not flow from its pot at low temperatures.

PILL 3 – INERTIAL FORCE

The idea of inertial force can be easily explained with examples (a colliding car causing its passengers to shoot forward as if a force were propelling them against the windshield), but the physical concept is not so simple (there is no such force that drives the passengers, nothing has interacted with them). The force of inertia is something virtual used in Physics to apply Newton's law $(F = ma)$ to a body that changes its speed or path of travel.

Talking about virtual force seems to diminish its importance, but it has a great relevance in the operation of industrial equipment. Imagine a robot or a numerical control machine or a 3D printer: in all of them there are pieces that move from one point to another, commanded by a computer program. We can type in the computer the conditions of this movement, for example: *move 2mm from the initial position accelerating from 0 to 10mm/s, then continue 10mm more in the same direction at 10mm/s until reaching the final position*. The moving part weighs 100g, and is mounted on a belt driven by a stepper motor. Do you think this movement is viable? What do you think would happen if it was programmed as is? If this is not possible, how should the program be modified?

HELP	
	First check what these values mean in terms of movement, speed, and acceleration. How long will it take to move in the first stage? What will its acceleration be? And what about its inertial force? In order to solve this, use the equations of uniformly accelerated motion: $v = v_0 + at$ and $x = x_0 + v_0 t + \frac{1}{2}at^2$ where *x* is the distance, *v* is speed, and *a* is acceleration. The subscript 0 refers

	to the initial instant, in our case $x_0 = 0$ and $v_0 = 0$. In the first stage, acceleration is 2,5m/s^2, and the time for this movement is 0,04s. Is this true? The inertial force is $F_{in} = ma = 0.25N$. Take a good look at the units.
	The second stage is clearly not possible: the part cannot go from 10m/s to 0 instantly, the (negative) acceleration would be infinite and so would be the inertial force.
	The motor that controls the movement has its own limitations and will adjust the movements to its possibilities, for example, when braking in the second stage, it may move beyond the desired final position, precisely due to inertia. In the first stage, it may not be able to reach the programmed speed, and consequently the speed in the second stage will not be constant. In any case, the stress to which we are subjecting the different pieces of the mechanism (motor, belt, the anchoring of the piece to the belt…) if we program inappropriate conditions will entail wear that must be assessed.

FINAL REMARKS

This type of calculation allows us to draw conclusions about the design of devices like the one we mentioned before. They mark the limitations in terms of speed or direction changes depending on the mass of the moving parts, the response times of the devices that control the movement, and the precision of time measurement and positioning.

Something similar to what happens in a change of speed in a straight trajectory happens in a change of direction. For example: the piece will not be able to make an exact right turn in its movement while maintaining speed, it will be necessary to lower the speed before the change of direction or design a trajectory with a certain curvature.

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PILL 4 – TEMPERATURE AND TRANSMISSION OF HEAT

There are a number of physical concepts for which common language is really misleading, even sometimes exactly the opposite of what would be said in scientific language.

A clear example of this is the concepts of temperature and heat: we say that something is hot when it has a high temperature, or we say that *we* are hot or cold, when in Physics, specifically in Thermodynamics, heat is a property of exchange between two bodies; bodies *have* no heat, they *exchange* heat with other bodies.

It is not just a question of subtlety, we can internalize ideas that lead us to wrong conclusions if we take them for granted. For example: when we wash our hands in a public bathroom and then dry them in the air dryer, a curious phenomenon occurs; first the air seems cold, and as your hands dry, it seems to get hotter. Can you think of why this is? Another example: two plates, one made of plastic and the other made of metal have been heating up in the oven next to each other. You are distracted and pick them up; when you touch the metal one it burns like hell, but the plastic one doesn't burn so much. One could say that the metal plate is hotter, but does the metal reach a higher temperature? Try to explain these two phenomena.

<table>
<tr><td rowspan="2">HELP</td><td>The two phenomena have to do with the fact that temperature and heat are two completely different physical properties: temperature is a property of the substance, a certain point of a body of a certain material is at one temperature or another. It might not be uniform throughout an entire body, like with a spoon used to stir a stew, which will have a higher temperature on the end inside the pot than in the handle.

When two bodies are at different temperatures and there is no thermal insulator between them, the body at a higher temperature transfers heat to the one at a lower temperature, and the temperature tends to balance. In the example of the spoon for the stew, heat will be transmitted from the end inside the pot to the handle. If we leave it in for a while, the handle will also be hot.

The speed for the heat transmission depends on the thermal conductivity of the bodies that are in contact and the space or body separating them (if at all).</td></tr>
<tr><td>The two phenomena described at the beginning of this Pill have to do with the</td></tr>
</table>

	fact that what we feel through the skin when something is hot or cold is actually *not a temperature sensor* but a *heat transmission speed* sensor. We deem something as "hot" when it transfers heat to our skin quickly, and cold when it is the other way around, and our skin transfers heat to the body we are touching. Can you explain these two phenomena now?
	The air from the dryer is always at the same temperature, but first the water in your hands is evaporating, absorbing heat from your skin and from the hot air (thus, you feel cold). As the hands dry (the water fully evaporated), you notice the heat the air directly transmits to us, and it seems warmer.
	In the second example, metal is much more heat conductive than plastic, so the heat exchange between metal and skin is much faster; plastics are generally poor heat conductors. Thus, both plates are at the same temperature (they are both balanced to the oven temperature), but the metal plate feels a lot hotter to the touch.

FINAL REMARKS

Measuring the temperature of a body can be done with a thermometer. There are many types of them, but in essence they require a system or body with a physical property that depends exclusively on its temperature. The classic example is mercury, whose density depends on its temperature (measuring the length of the mercury capillary enclosed in the glass rod has served since ancient times). The thermometer is put in thermal contact with the body in question and we allow heat to be transmitted between them until they balance, to be sure that the temperature of the thermometer is equal to that of the body. As we explained on another pill, it is necessary to previously calibrate the thermometer with two fixed temperature points: traditionally, a bath of liquid water and ice (0ºC) and boiling water (100ºC) both with atmospheric pressure. These values are marked on the thermometer rod, and 100 divisions between them are made.

Mercury thermometers are nowadays in disuse due to the toxicity of mercury, and have been replaced by other systems, which have in common the fact that they have a physical property that depends only on temperature: the electrical resistance of a platinum conductor, the electrical potential that creates in the union of two metals, infrared radiation etc.

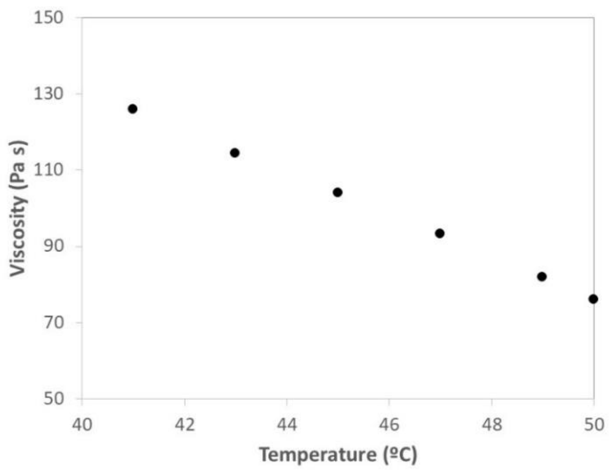
AREA 3: BASIC TECHNOLOGIC TRAINING FOR EMPLOYABILITY

D.U.2 – MATHEMATICAL CONCEPTS, CALCULATION TOOLS: acquiring knowledge on mathematical concepts and methods.

PILL 1 – FIRST DEGREE EQUATIONS

We are working with a very viscous liquid, too viscous to be handled in a specific industrial process. We want to take advantage of the fact that viscosity decreases noticeably with increasing temperature, so we make a series of viscosity measurements at different temperatures between 40ºC and 50ºC (shown in the table). With these data we can represent a graph like the one in the figure below.

Temperature (ºC)	Dynamic Viscosity (Pa s)
41	126
43	114,4
45	103
47	93,2
49	85
50	80,1



It seems like the relation between viscosity and temperature is linear. In any case, the viscosity at 50ºC is still too high for this process, so we are interested in estimating at which temperature the viscosity value would equal 50 Pa·s. This extrapolation can be done by fitting the data to a straight line and once we have an equation, calculate from it the required temperature.

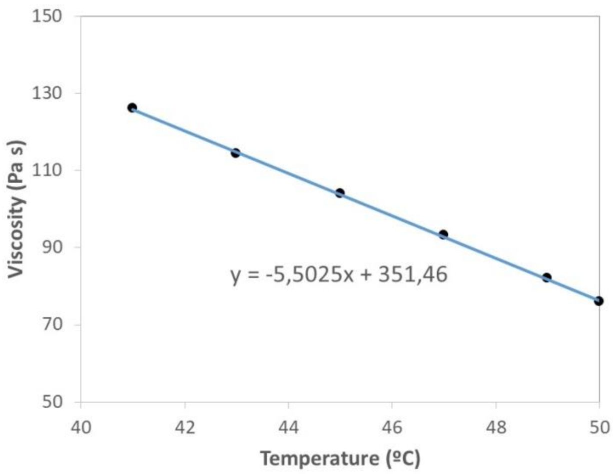
You can do this very easily for example in an Excel spreadsheet. Enter the data to form a table, create the graph like the one in the figure from it, and use the command that allows data to be adjusted to the line ("trend line"). Look for a tutorial on how to do this or look for help in Excel, find the linear equation you need, which will be of the form: $\eta = A + BT$ where η is the dynamic viscosity and T is temperature. You can solve the problem with that equation.

HELP	
HELP	This is about drawing the trend line on the graph (the straight line that best fits the experimental data). You will get a graph like the one in the following figure, and on the graph you can ask Excel to write the equation for that line.

In said equation, *y* is viscosity and *x* is temperature, so we have:

$\eta = 351.46 - 5.50T$ (1)

The temperature coefficient is -5,50 (it is negative because it has a negative slope, meaning that viscosity decreases with increasing temperature).



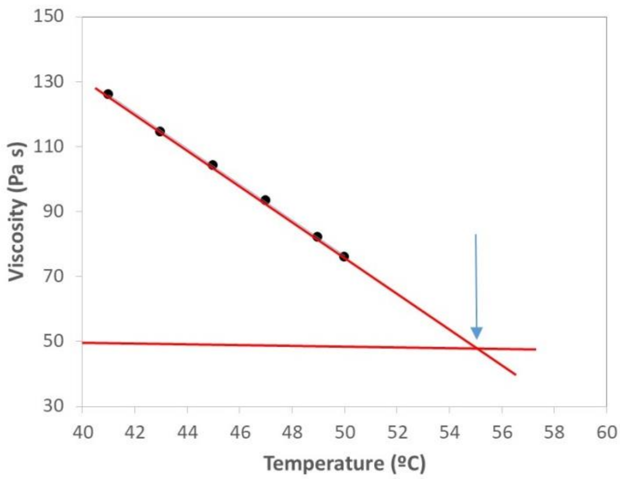
Now we have to calculate the value of *T* for η = 50, for which we have to solve the equation: $50 = 351.46 - 5.50T$, or $50 - 351.46 = -5.50T$.

$$T = \frac{50 - 351.46}{-5.5} = \frac{-301.46}{-5.5} = \frac{301.46}{5.5} = 54.8ºC$$

, which is the temperature we were looking for.

In the previous help we solved the equation analytically, but it can also be solved graphically: just draw the graph with a wider temperature and viscosity interval and extend the straight line until you see where it intersects with the horizontal line of η = 50 Pa·s, as in the figure below.

This is actually the meaning of solving the linear equation, looking for the point where the second member of the equation (1), the straight line, equals 50.



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FINAL REMARKS

Extrapolating the trend of some data is always risky. In this case, the result is based on accepting that the relationship between viscosity and temperature is a straight line, which is not exact. You see a straight line in the graph because the temperature interval of the measurements made is narrow (just 10ºC), if it were wider you would see that there it has a curvature.

This means that you have to expect some margin of error, which can be very high if we extrapolate to points far beyond the range of the experimental data (in this example we only go 5ºC beyond the last point, so there should not be much a problem). You can fit the data to more complex equations, making the error smaller.

PILL 2 – SYSTEMS OF EQUATIONS

This activity is aimed at studying the meaning of a system of linear equations and its solution. For example:

$$y = -x + 1$$

and $3y - 6x = 6$

These two equations are two straight lines that can be represented on an x-y diagram. You can solve the system analytically or you can represent the two lines graphically and see the point of intersection yourself.

Explain in your words why the solution of the system is the point of intersection of these two lines.

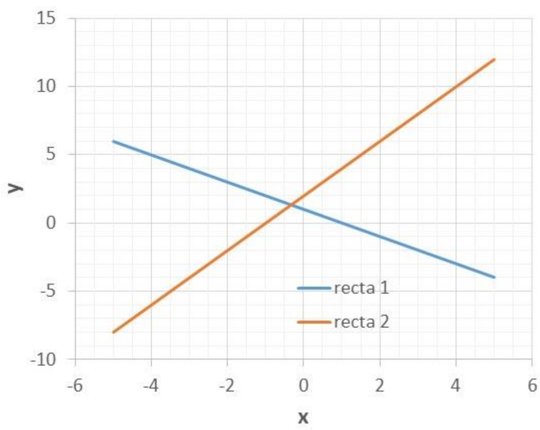
HELP

To graphically represent the two straight lines, first clear *y* in both equations (the first one is already cleared), so the system remains:

$$y = -x + 1$$

and $y = 2 + 2x$

The two lines are represented in the graph:



The point of intersection is given when $x = -{}^{1}/_{3}$ and $y = {}^{2}/_{3}$

These values are the solution of the system of equations, because the point

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	$(x, y) = (-{}^{1}/_{3}, {}^{2}/_{3})$ fulfills both equations.
	To solve the system of equations analytically, once we have cleared *y* in both equations, we can equalize the right sides of the two equations because they are both equal to *y*: $-x + 1 = 2 + 2x$ Adding *x* to both sides to not change the equation, it remains: $1 = 2 + 3x$ Now subtract 2 from both sides: $-1 = 3x$ And divide by 3 in both sides to clear *x*: $x = -\frac{1}{3}$ Now, substituting in either one of the equations, we find that $y = {}^{2}/_{3}$, which is the solution to the system, because the point $(x, y) = (-{}^{1}/_{3}, {}^{2}/_{3})$ is a point in both straight lines.
	When we say that what adds to one side of the equation can pass to the other side with a negative sign, or what is multiplying in one side passes to the other by dividing, it is actually because the operation is done to both sides of the equation, as you have seen in the previous lines.

FINAL REMARKS

The connection between the written form of functions and their graphical representation is a key tool in understanding what they mean and how they behave. Handling a spreadsheet makes representing a function, no matter how complex, very easy.

An equation like $3y - 6x = 6$ becomes a function when we solve for one of the two variables (in this case *y*), when you could call it "a function of x" *y = f(x)*, since *y* takes different values for each different *x* value. In in this case their relationship is linear, meaning that the graphical representation of $y = 2 + 2x$ is a straight line.

PILL 3 – THE SLOPE OF A LINE

Perhaps you know the story of a king who wanted to reward a citizen by offering them anything he/she asked for. The citizen asked the king for grains of rice in a chessboard, first 2 in a corner square, 4 in the one next to that one, and so twice as much in the previous one in each of the following squares. Due to this slow start, the king didn't think the citizen was asking for much, but if you do the calculations, the resulting number is huge: square 21 would already have more than two million ($2 \cdot 10^6$) grains of rice, and in the last square (square 64), an astonishing total of $1{,}8 \cdot 10^{19}$ grains of rice, which no king on earth had.

As an equation, the number of grains of rice (*y*) is a function of the number of squares already been filled with rice (*x*). In the first square the number of grains is $2^1 = 2$, in the second $2^1 \cdot 2 = 2^2 = 4$, in the third $2^2 \cdot 2 = 2^3 = 8$ … and thus, for any *y* square, the number of grains will be 2^x.

Draw the function $y = 2^x$ on a spreadsheet. Notice how the bigger *x* is, the faster *y* grows.

Find the meaning of the slope of a function at a given point, and draw the slope for $x = 10$ and $x = 60$.

HELP	
HELP	In the spreadsheet, draft a column with arbitrary *x* values and edit the values of $y = 2^x$ next to it. Column A has the values of *x*: cell A6 has the value 1, cell B6 has the function = *2^A6*. Now, copy cell B6 into cell B7, which will show = *2^A7* (when copying down, the reference to the cell is corrected to the same extent). In A7, write *=A6+$A$3* and thus add two units to cell A6. And that's it, cells A7 and B7 are copied down as many times as you want, so the attached table is the result. If you need further points for the graph, you can write a smaller number in A, if you want to have less, write 3 or 4. The next step is to create the graph, which should look like *Figure 1*. It looks that until box ~50 the number of rice grains is too close to 0; what is happening?

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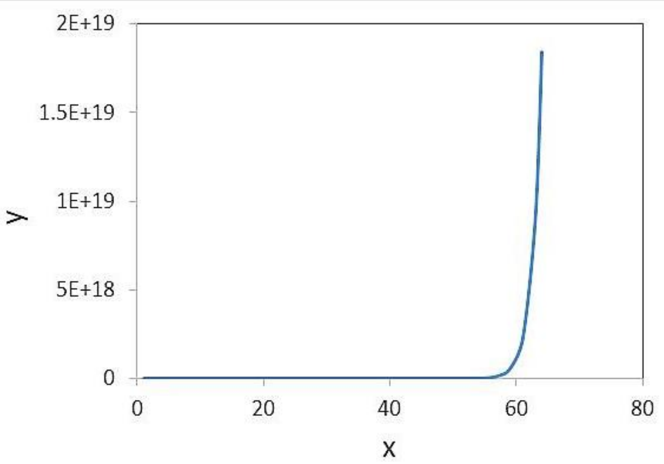
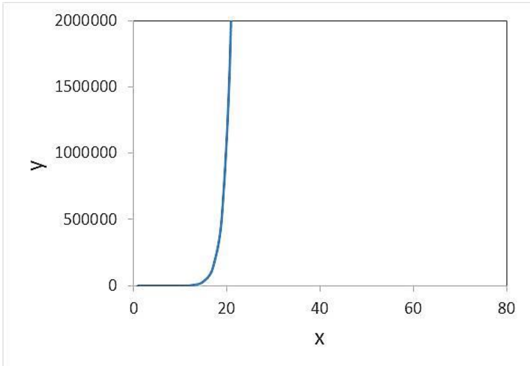
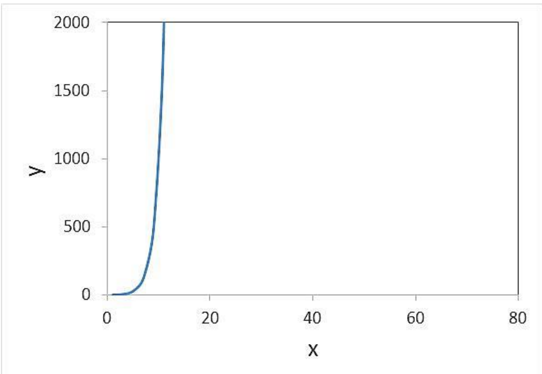


Figure 1

	A	B
	2	
5	**x**	**y**
6	1	2
7	3	8
8	5	32
9	7	128
10	9	512
11	11	2048
12	13	8192
13	15	32768
14	17	131072
15	19	524288
16	21	2097152
17	23	8388608
18	25	33554432
19	27	134217728
20	29	536870912
21	31	2147483648
22	33	8589934592
23	35	3.436E+10
24	37	1.3744E+11
25	39	5.4976E+11
26	41	2.199E+12
27	43	8.7961E+12
28	45	3.5184E+13
29	47	1.4074E+14
30	49	5.6295E+14
31	51	2.2518E+15
32	53	9.0072E+15
33	55	3.6029E+16
34	57	1.4412E+17
35	59	5.7646E+17
36	61	2.3058E+18
37	63	9.2234E+18
38	64	1.8447E+19

It is a question of scale; since the highest value (x = *64*) is so huge, the first ones are actually very close to 0 in comparison. When represented in a graph with the upper limit of y set to $2 \cdot 10^6$, it only show up to $x = 20$, the rest are larger than what is shown (Figure 2).





Notice that the curve in this graph still looks very similar to that of Figure 1. The number of rice grains grows very fast also in this area, and if the limit of the graph is set to 2000 (Figure 3) we still see something similar in the first 10 cells.

This is a function with a huge slope, meaning that the value of the function (y) grows very quickly even for small variations of x, and its slope grows

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increasingly.

Graphically, the slope is the line tangent to the curve at each point. Figure 4 shows the slope at x = 50, in a graph drawn in the appropriate scale, so it can be better appreciated.

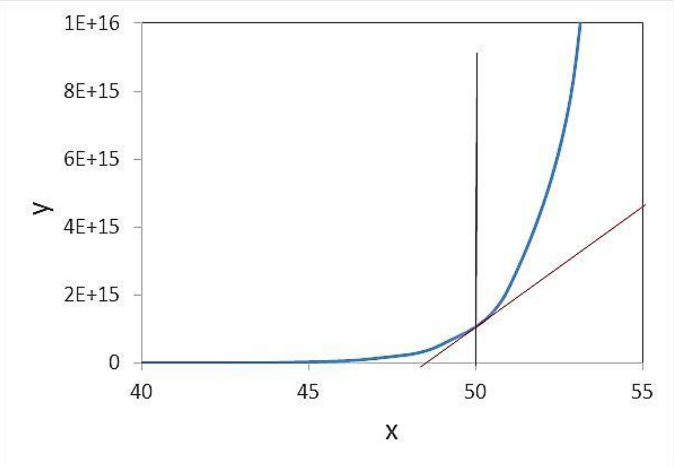


Figure 4

FINAL REMARKS

The slope of a function is related to the concept of derivative equations. Delving deeper into this would require more time and a higher mathematical basis than what we intended for this course.

PILL 4 – DRAWING A PARABLE; SOLUTION TO THE SECOND DEGREE EQUATION

A second degree equation has the form: $ax^2 + bx + c = 0$ (1)

Its solution or solutions are the value or values of *x* that when substituted in the left side of the equation make the whole equal 0. If you do not remember how the solution is found, you can easily find out online that its solution is: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ (2)

The ± sign means that there are actually two solutions, two possible values for *x*, one positive and negative, that will equal 0 when entered in the equation. Only one of those two solutions remains when $b^2 - 4ac = 0$, meaning that sometimes there is only one solution.

It could also be that $b^2 - 4ac < 0$, and so the square root would not exist and there would be no solution.

Let's try to understand this by solving the equation analytically and graphically:

$x^2 + 4x + 1 = 0$ (3)

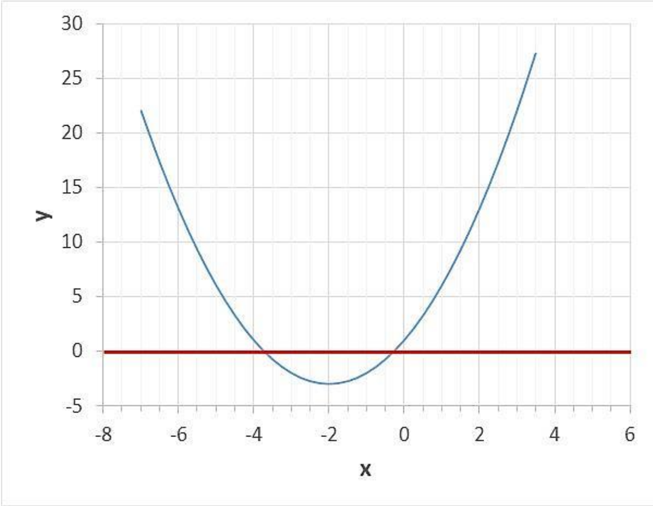
Solving this equation graphically simply means to draw a graph of the values taken by $x^2 + 4x + 1$ when you give different values to *x*. You can use an Excel spreadsheet; the solution to the equation will be the point or points at which this function equals 0.

Change the values of *c* in equation (3); when does the equation have only one solution and when does it have none?

HELP	In the spreadsheet, draft a column with arbitrary *x* values and edit next to it the values of $y = x^2 + 4x + 1$. Copy them as shown in the table, and make a graphical x-y representation (dispersion) like the figure. The function $y = x^2 + 4x + 1$ is a parable, represented by the blue line. That line cuts the straight line *y = 0* at **two** points, *x = -0,27* and *x = -3,73* , which are the two solutions of equation (2). $$x_1 = \frac{-4 + \sqrt{4^2 - 4 \cdot 1 \cdot 1}}{2 \cdot 2} = \frac{-4 + \sqrt{12}}{4} = -0{,}27$$

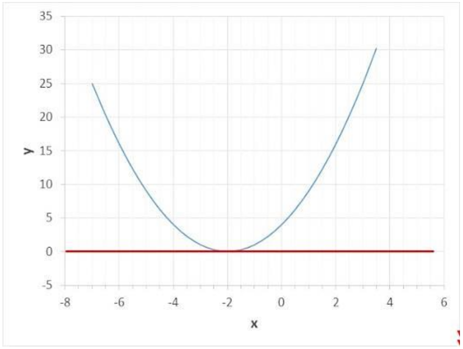
x	y
-7	22
-6,5	17,25
-6	13
-5,5	9,25
-5	6
-4,5	3,25
-4	1
-3,5	-0,75
-3	-2
-2,5	-2,75
-2	-3
-1,5	-2,75
-1	-2
-0,5	-0,75
0	1
0,5	3,25
1	6
1,5	9,25
2	13
2,5	17,25
3	22
3,5	27,25

$$x_2 = \frac{-4-\sqrt{4^2-4\cdot1\cdot1}}{2\cdot2} = \frac{-4-\sqrt{12}}{4} = -3{,}73$$

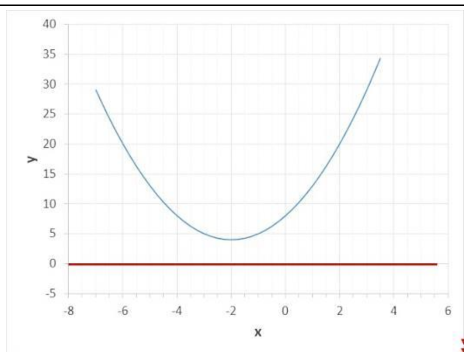


When *c* increases in value, the parable moves upwards.

At *c* = *4*, the parable just touches the line of *y* = *0*, so the equation has only one solution (*x* = *-2*).



When *c* is greater than 4, then the parable does not even touch the line of *y* = *0*, so the equation has no solution.



FINAL REMARKS

Spreadsheets include very useful tools not only to perform calculations but to make them understandable, to represent functions, and get a clearer picture of the problem. They are worth the time it takes to learn how to use them.

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AREA 3: BASIC TECHNOLOGIC TRAINING FOR EMPLOYABILITY

D.U.3 – PROPERTIES OF MATERIALS: the set of characteristics that make materials behave as they do before external stimuli.

PILL 1 – STRESS-STRAIN DIAGRAM

The characterization of the mechanical behavior of a deformable solid is a very complex problem. A force applied to one point of a piece of a material produces a deformation that can be very different in some points and in others, both of its surface and its interior. As a simple example, you can see what happens to a rectangular shaped flat piece when we stretch it from its two narrow sides:

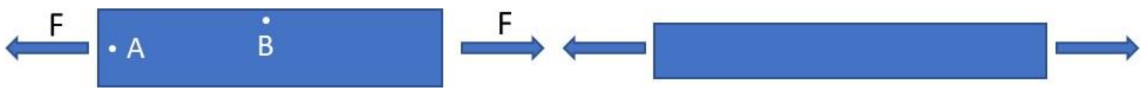

Figure 1: Deformation of a rectangular flat piece under forces applied at the narrow ends. Left: before deformation. Right: deformed piece.

The piece lengthens due to the action of forces, but at the same time it narrows, keeping the total volume constant. Notice that due to the application of force, a point on the side of the piece, like A, moves to the left, but another point on the center of the piece, like B, moves down.

The extent to which the piece deforms for certain applied forces depends on its rigidity. We all have internalized the idea of what a soft or rigid material is (very deformable or not so much), but quantifying that property, putting numbers to rigidity or mechanical resistance, requires being more specific.

To begin with, if we want to measure the rigidity of a material, it is necessary to define that property in such a way that it only depends on the material, not on the shape of the piece. Thus, when making the experimental measurement, the shape of the piece and the test protocol must be defined in such a way that it allows us to calculate a property of the material and not of the piece.

There is a case in which the deformation behavior of the material is especially simple and it is that of a piece like the one in figure 1 but very narrow, like a thread (a piece in which the cross section is very small compared to its length). In this case, we could speak of a single applied force and a single deformation, the elongation of the thread. For the properties to be independent of the shape of the piece, the applied stress σ is defined as the quotient between the force F and the cross section A, and the deformation ε is defined as the unit elongation, meaning the increase in length Δl divided by the initial length, l_0.

$$\sigma = \frac{F}{A} \qquad \varepsilon = \frac{\Delta l}{l_0}$$

Note that the unit of tension is Pascal (Pa), which is 1 N/m^2, a really small value which would be approximately the tension that 100g of weight would exert when placed on the surface of a 1m^2 square table.

When a piece of this type is stretched in a stress-strain testing machine, the length of the piece increases at a constant speed, the machine measures the force needed, and draws a diagram like the one in figure 2.

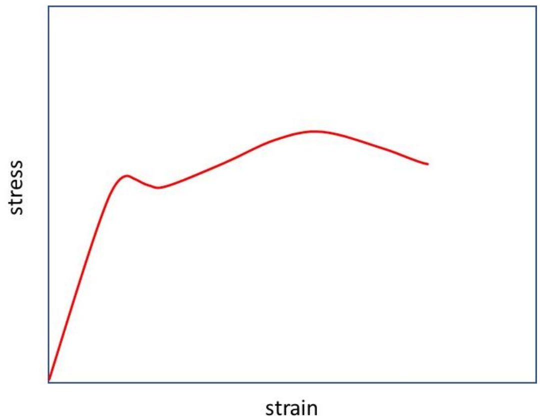

Figure 2: Stress-strain diagram of a metal.

This diagram defines how deformable the material is, and the maximum force it can resist before permanently deforming or breaking. Look for information on the following concepts and mark them in the diagram: elastic modulus, elastic limit, yield stress, breaking stress, and elongation at break.

HELP	Starting with the elastic modulus (E), it is defined for a range of deformations in a material in which the relationship between stress and strain is linear, meaning that if twice the stress is applied to the material it deforms twice. Linear behavior is also called elastic behavior. It happens for small deformations. The point on the diagram where the behavior is no longer linear is called the elastic limit; what happens to the material, within the elastic limit, when we eliminate the applied force?
	When the elastic limit is exceeded, the material is said to flow. In the stress-strain diagram, the stress reaches a point where it stops increasing, and the material deforms without the need to apply a greater force. The yield stress is

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	the maximum point of stress in this region. What happens to the material when we eliminate the applied force, if the elastic limit has been exceeded?
	For large deformations, the stress-strain curve can vary greatly from one material to another due to how the deformation itself affects the molecular arrangement of the material. At a given point, the material will break; the machine records the break and the last point measured gives us the breaking stress and the elongation at break.

FINAL REMARKS

The numerical values of the elastic modulus or the stress in the elastic limit can vary enormously from one material to another, as you can imagine if you mentally compare the deformability of a small steel wire with that of an elastic band; or the elongation at break of a ceramic or glass with that of a plastic such as polyvinyl chloride, PVC. Look for numerical data too to better understanding these concepts.

PILL 2 – MECHANICAL FRACTURE

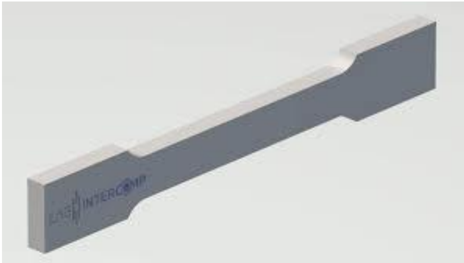
When you want to measure the resistance to fracture of a solid material shaped as a rectangular test piece, for example, one finds that the measurements are not very reproducible. The reasons for this are the mechanics of the fracture itself, it is not easy to explain: when a force system is applied to a solid, a different tension (force per unit area) acts at each of its inside points; different in terms of its magnitude and also in terms of the direction in which it is acting.

If there is a flaw inside the material, a pore for example, the tension acting around it will be greater than at any other point of the piece. And if the flaw is not spherical but has the shape of a groove ending at an acute vertex, the stress at that vertex will be even higher; that is what is called a stress concentrator. So when we apply force to our test piece, the first point to accumulate enough stress to break the material will be at the tip of a crack that already existed in the material. The piece breaks from this perhaps invisible crack or pore that already existed before starting the test, becoming a crack that advances incredibly fast through the piece and ends up breaking it.

Bearing this in mind, look for information on how test pieces have to be manufactured to be able to measure the tensile fracture properties of a metal, and explain in a few lines why they have such a particular shape and way of manufacture.

HELP

You will immediately find that standard test pieces have the shape shown in the figure, or similar shapes with a circular cross section. The areas in which the pieces are clamped with the jaws of the machine are wider than the central area. Why is this so?



We have stated that fracture occurs when a crack grows from a flaw in the piece, so the manufacture of test pieces has to prevent these defects from occurring on the surface. For example, the pieces cannot be cut from a plate using whatever cutting tool, because there would be cracks at the edges that would initiate the fracture, thus invalidating the results of the test. This is obvious for metals, but when testing plastic one could think of resorting to scissors.

FINAL REMARKS

The phenomenon of stress concentration is of great interest in the production of parts by 3D-printing. Technologies have been developed to produce metal, ceramic, or plastic parts by additive manufacturing. One of them for metal parts is based on depositing layers of metal powder which are then fused at the required points by a laser beam, to form the piece layer by layer. A problem these pieces can have is that there can be pores inside, which make the piece less resistant to fracture than with other methods of manufacture. The same could be said for plastic filament 3D-printers, which can also produce internal pores, but in this case we must add to this problem the issue of the adhesion between printed layers, which also entails less resistance to fracture, which would no longer be caused by a crack, but by the simple detachment of the two weakest layers from one another.

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PILL 3 – POLYMERS; VISCOELASTICITY

Polymers are materials with a very particular mechanical behavior with a propensity to maintain deformations permanently, which is precisely why they are called plastics. There is an incredible variety of polymers, with different chemical and molecular structures, but their mechanical response has a key feature: the **viscoelastic** behavior.

When instantaneously applying a force to a metal or a ceramic, we expect also an instantaneous deformation (at least in what we understand as instantaneous and what we are able to register experimentally); however, if you hang a weight from a polymer thread (nylon for example), it is easy to see an initial instantaneous deformation, but then the thread will continue to elongate little by little. Depending on the temperature, the polymer in question, or the applied weight, the thread could be stretching for **years**. This length can reach a stable value in some polymers, but in others the deformation increases indefinitely (until breaking point). At any point in the process, if you were to remove the applied weight, you would find the opposite process: the thread instantly recovering part of the deformation, and then continuing to contract little by little, until fully regaining its initial length, even if it takes a long time to do so. That’s where the term *viscoelasticity* comes from: *elastic* because the deformation is recovered by eliminating the applied force, and the *visco* prefix comes from the fact that the deformation behaves like a viscous fluid.

The deformability of polymers is much higher than that of other materials, for example, a rubber band can be lengthened up to 10 times its length and fully regain its initial length when a force is no longer applied to it. This high deformability and the fact that it takes a certain time to produce are linked to the structure of the polymer. Could you explain what makes the polymer so deformable? Find out what the creep curve of a polymer is, how it is represented and the shape it has.

HELP	The particular behavior of polymers is linked to their molecular structure. The mental image of the polymer chain you can make is that of long sewing threads coiled and tangled between them. Imagine stretching a skein of tangled threads; they would really stretch quite a bit, depending on the flexibility of the thread itself, but even a skein of metal wires could be stretched a lot with little force.

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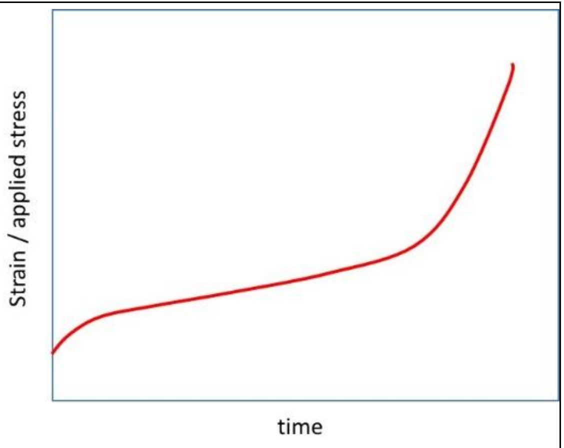
The creep curve for tension shows the elongation of a sample with a small cross section, when a force is applied at its ends and kept constant.



In order for the curve to represent the properties of the material, not the characteristics of the test itself, it represent the quotient between the unit elongation (increase in length Δl divided by initial length l_0) and the applied stress (force F divided by the cross section A, in units of tension, which in IS units are Pascal: N/m^2).

FINAL REMARKS

The versatility in the manufacture of polymers allows us to produce materials with custom-made properties, but then, another additional difficulty in collecting the characteristics of their mechanical behavior is precisely their wide range of variants, with different amounts of mineral fillers, additives, lubricants, colorants… It is necessary to have the properties of the specific material that you are going to use, so polymer manufacturers often include the creep curve in the characteristics of their materials.

PILL 4 – POLYMERS; EFFECT OF TEMPERATURE

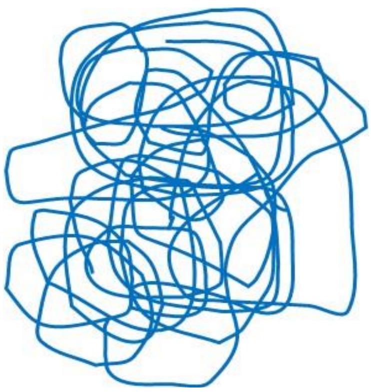


Figure 1: Structure of the macromolecular tangle of an amorphous polymer.

One of the essential characteristics of polymers is the extent to which temperature affects all their properties. In this exercise, we'll show you amorphous polymers; in them, the molecules form messy tangles that intertwine with each other, as in the diagram in Figure 1.

These polymers show a radical change in behavior around their **glass transition** temperature (T_g); at temperatures below T_g, the material behaves like a rigid solid. Polyvinyl chloride (PVC) for example, whose T_g is around 80ºC, has the appearance of the material of drain pipes, or joinery elements such as door and window frames below that temperature. However, over

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80ºC it softens, becomes easily malleable, with the appearance of rubber. Other amorphous polymers have their T_g at temperatures below room temperature. India rubber has a T_g below -100ºC, so it behaves like rubber at room temperature.

The graph in Figure 2 represents the elastic modulus of polymethylmethacrylate (PMMA), with a T_g of around 125ºC, subject to temperature. It is represented in base 10 logarithm (log E), measured in N/m^2 (Pa). Log 10 is used so that very separate values of E can appear on the graph, because of how quickly its value decreases with increasing temperature.

Can you explain in your words how the elastic modulus of PMMA changes when the temperature increases between 50 and 200ºC?

In order to understand what these changes mean, calculate how much a PMMA thread of $1mm^2$ cross-section and 20cm long would stretch if you hang a 1kg weight from it at 50ºC. Repeat the calculation for 200ºC.

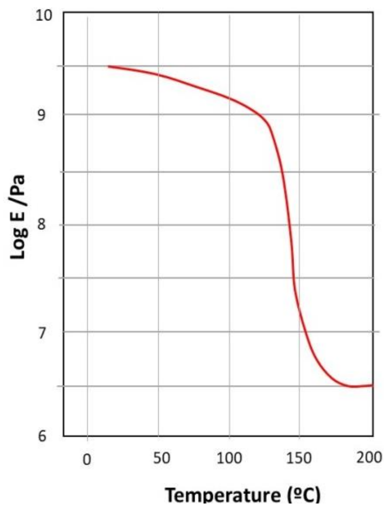

Figure 2: Elastic module of polymethylmethacrylate subject to temperature.

HELP	You know the meaning of elastic modulus from other Pills. Here, perhaps the first thing is to understand the logarithmic scale of Figure 2. This means that, if for a certain temperature the value of log (E/Pa) is 9,5 (like for temperatures around 20ºC), the elastic modulus is $E = 10^{9,5} Pa = 3.162.277.660 Pa$. In Figure 2, at 200ºC, log (E/Pa) = 6,5, so $E = 10^{6,5} Pa = 3.162.277 Pa$. 1000 times smaller!
	When describing the shape of the curve, note where the glass transition temperature is located, and how the slope of the curve changes, meaning the rate at which the elastic modulus changes in one and the other side of that temperature.
	The elastic modulus is $E = \frac{\sigma}{\varepsilon}$, where σ is stress $\sigma = {F}/{A}$, and A is the cross section, in this case $\sigma = \frac{9,8\ N}{10^{-6} m^2} = 9,8\ 10^6 Pa$.

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	Thus, the elongation at 50ºC, where log E = 9,4 is $\varepsilon = \frac{\sigma}{E(50^{\circ}C)} = \frac{9{,}8\ 10^{6}}{2{,}551\ 10^{9}} = 0{,}0039$. Note that elongation is dimensionless. The increase in the length of the sample will be $\Delta l = \varepsilon l_0 = 0{,}78mm$, which is not a noticeable elongation. At 200ºC the elastic modulus is $E = 10^{6.5}Pa = 3.162.277Pa$, and the increase in length would be 620mm. For much smaller deformations, the elastic limit would be exceeded, the relationship between stress and deformation would cease to be linear, and the thread would surely break under the applied load.

FINAL REMARKS

The elastic modulus varies very rapidly and exponentially with increasing temperature; this happens with many properties of polymers at temperatures above their glass transition. For example, electrical conductivity or the diffusion coefficient of liquids or gases through a polymer increases exponentially with temperature. These properties are related to molecular mobility: with increasing temperature, the speed with which polymer chains move and reorganize increases exponentially.

AREA 3: BASIC TECHNOLOGICAL TRAINING FOR EMPLOYABILITY

D.U.4 – GRAPHICAL REPRESENTATIONS: Useful tools for the presentation and analysis of the results of a test or experiment.

PILL 1 – THE IMPORTANCE OF ANALYZING YOUR RESULTS

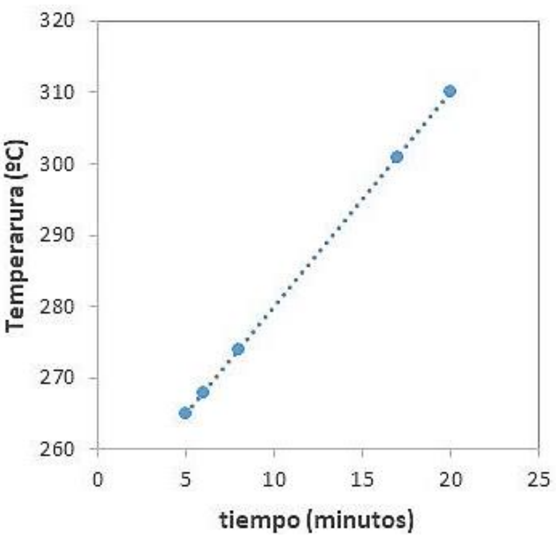
The laboratory of your company carried out a thermal dissipation test, measuring the temperature of a piece that you had designed and built as it was heated. The results were:

TIME (min)	TEMPERATURE (ºC)
5	265
6	268
8	274
17	301
20	310

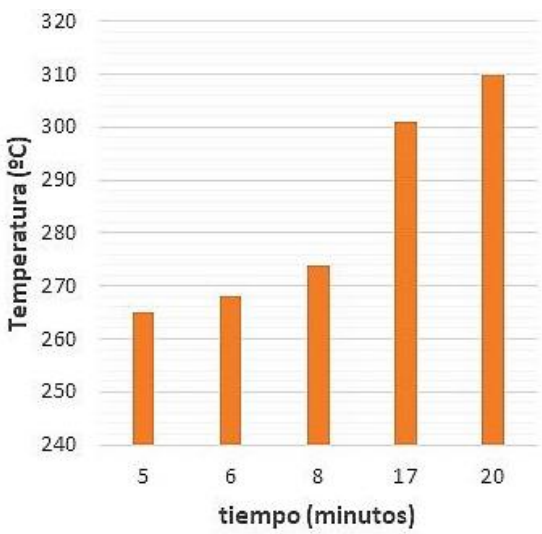
When presenting the results, the lab staff generated different graphs.

What conclusions do you draw from the essay? Is there a critical point to analyze? Which one? What is the degree of thermal diffusion?

A



B



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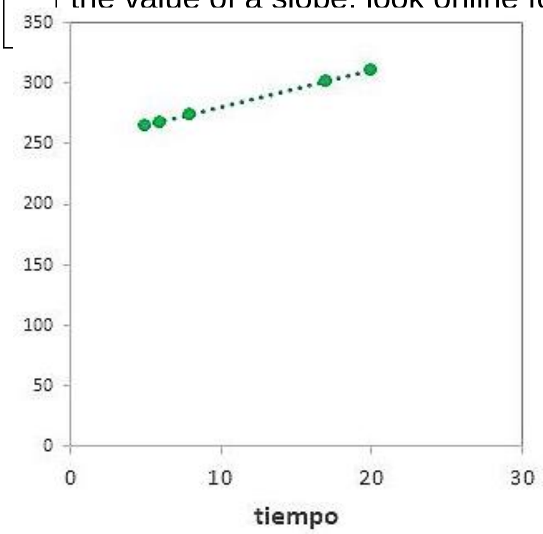
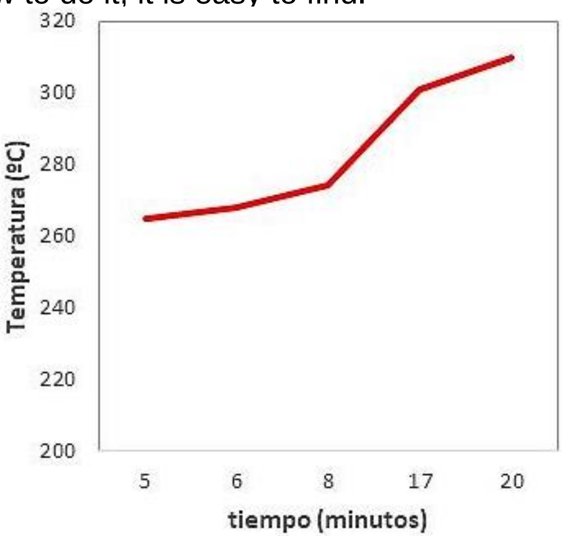
HELP	It is obvious that the lines are different in each graph. In cases like this, the first thing to do is to check if there was a mistake when creating the graph. Check if you can discard any of them for this reason.
	Once you verify the previous step, look at parts of the graphs, especially their axes. Is there any appreciable difference between them? Selecting the values to show in the axes is essential, and will modify the appearance of the graph.
	The degree of thermal diffusion shows how fast the piece heats up over time, and is calculated with the slope of the line. If you do not know how to calculate the value of a slope, look online for how to do it, it is easy to find.

C



D



FINAL REMARKS

When analyzing data obtained or working with graphs in technological environments, it is essential to understand what you are doing. Many mistakes and errors come from misinterpreting data, and not so much from mistakes in measurement, which is why you should never make decisions without first analyzing the results and checking if they are logical and agree with the previous working hypotheses.

In technology companies, misinterpreting a result can cost a lot of time and resources. The case we have seen is a clear example: graphs B) and D) can lead you to believe that the thermal diffusion of the material is not constant, that there are certain points where the heating rate increases. Graph C) can lead you to think that the heating rate is less than it really is.

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Even if all graphs are made with the same data, using graphs B), C), or D) could lead to major mistakes.

Although all data is well placed on the graph, B) and D)'s separation among the values of the X axis does not match the real separation of the values it represents (for example the distance between 6 and 8 is the same as between 8 and 17), making the graph appear to have an unreal and misleading shape. Furthermore, the selection of the types of graphs is not adequate, especially in the case of bars in B) and a line without points in D).

Lastly, notice that graph C) starts its numbering from 0, although the data starts at T = 265, making the graph seeming to have a lower slope than it should.

PILL 2 – OBTAINING A FUNCTION FROM A GRAPH

In your technology company, you need to foresee the behavior of a material against traction (meaning to apply a force trying to stretch a cylindrical test piece). You do a "traction test" applying a tension (force / area, but that is not important in this exercise) and you measure how much the piece has deformed (stretched); the test yields the following results:

TENSION (Pa)	DEFORMATION (non-dimensional)
33.557.046,98	0,00041
50.335.570,47	0,00062
67.114.093,96	0,00083
83.892.617,45	0,00104
100.671.140,9	0,00124
117.449.664,4	0,00145
134.228.187,9	0,00166
134.228.187,9	0,00250

Turn the results into a graph and infer, where appropriate, whether they have a linear, quadratic, or inverse proportionality relationship, and deduce the formula.

HELP	
	To represent the results graphically, do it either by hand or with software like Excel, with which you just have to copy the table and choose the graph format that suits you best. What type of graph would you chose?
	You have the graph, that is the easy part; now, deduce the formula that relates the two data, in which the strain equals the stress multiplied, divided, added, or subtracted by one or more numbers. But beware! You won't be able to use the

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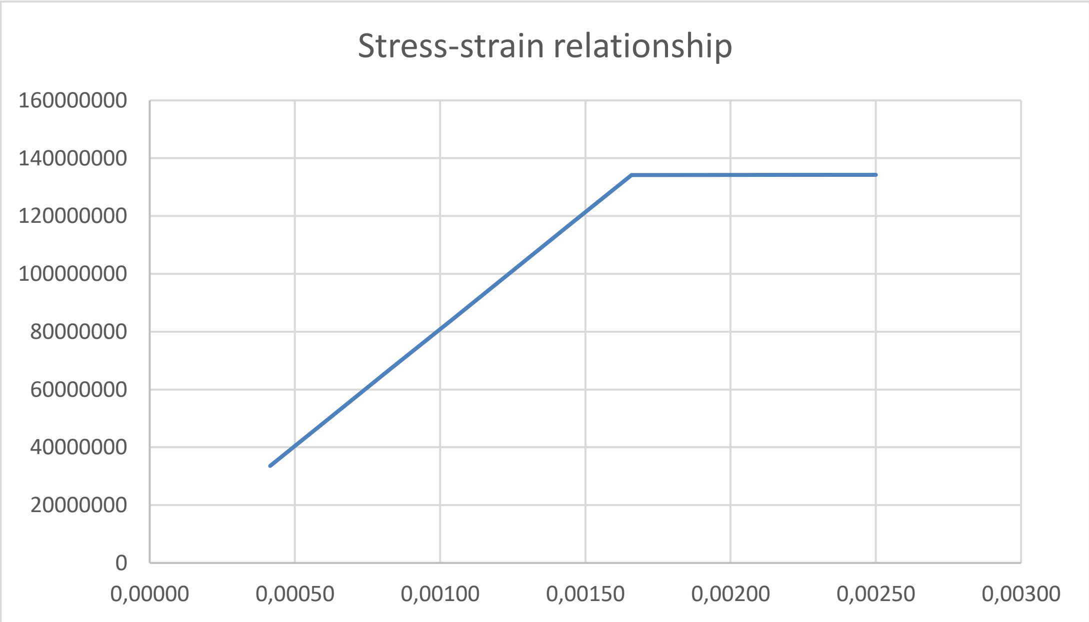
	same graph for all data, since there is a point where the trend changes.
	There is a webpage that explains how to do it; go there to do virtual tensile tests: http://recursostic.educacion.es/fprofesional/simuladores/web/index.php?xml=f-fabricacion&xsl=familia

FINAL REMARKS

If you have correctly completed the exercise, you will have generated a graph that changes its trend sharply at 134.228.187,9 (in the *y* axis). Before that, the line has an ascending straight trend, so the relationship between stress and deformation is linear: by multiplying a number to the stress you will get the deformation value. Just like that, you have managed to determine **Hooke's Law**.

Said number is called **Young's Modulus** (E) and it is incredibly important: it shows the elastic capability of a given material. What does this mean? In this case, that as long as you apply forces smaller than 134.228.187,9 N/m^2, the resulting deformation will be reverted when you stop applying force. Young's Modulus (E) defines the elastic capability of the material: the greater the number, the more the material can deform with a given force.

The point where the slope changes and becomes a horizontal line is the **elastic limit**; from there on, the deformation will not revert even if you stop applying the force. More so, a creep stage begins: from this point onward, the material will



deform very quickly even with smaller forces.

If you have passed this exercise… congratulations! It takes great analytical and detective skills to deduce the formula behind a graph.

The graph made with the EXCEL program is automatic (remember to choose a scatter graph as seen in the previous pill).

If you want to know the formula of the slope of the graph, we must realize that it has two different stages (trends):

- First, the one where the slope ascends.
- Second, the one horizontal (slope = 0).

In both stages the relationship is linear (meaning that the formula is simple, without squares or multiple variables). Since it is easier, let's start with the second part of the graph. The function for a horizontal line is as easy as knowing that its value for any *y* is the same:

y = 134.228.187,9

The first part is somewhat more difficult, but not so much:

y = *x* · (a given number) , so said number should be = *y* / *x* for any point. Thus, taking two values and making that calculation yields: 80.900.000.000, which is this material's Young's Modulus (E).

PILL 3 – YOU DON'T NEED TO KNOW THE TOPIC IN DEPTH… JUST HAVING ANALYSIS CAPABILITIES

A new device created by your company has been causing some issues. Theoretically, its current intensity should have the function:

voltage = 4sin (1000t)

where *t* is the time in which it is being measured. A test measuring the voltage of the circuit over time yields the following results:

TIME (s)	VOLTAGE (V)
1	1,653759081
2	1,860079009
3	0,438379949
4	-1,367007588
5	-1,975932878

6	-0,855439025
7	1,01377086
8	1,995686065
9	1,230893311
10	-0,611228778

Draw a comparative graph showing both the theoretical values and the test results (with voltage on the *y* axis). Are real values equal to the theoretical ones? Do you know why? What kind of current does the device use?

HELP	Never be distracted by statements: you just have to understand them and know what they are asking for. This being a problem about electricity doesn't matter, it could be about speed or heat, it asks you for a comparative graph, so you just have to draw a graph with two lines, one for theoretical values and another for real ones, with voltage on the *y* axis.
	The not so difficult part is that, although the lines on the graph could seem complicated and electricity is difficult to understand, the question itself is not difficult to solve. Take a look at the *y* axis (voltage) for each of the lines. What is happening? What is the maximum value of the voltage?
	Now go online; there are two types of current: alternating (AC) and direct (DC). One comes from less powerful sources that can supply a constant voltage over time, and others.

FINAL REMARKS

With this pill we wanted you to analyze the text. It could seem very complicated at first glance, because it encompasses complex areas of knowledge, but often problems do not require in-depth knowledge of complex issues, but just for you to understand what is asked of you and put what you know into practice.

Here, you might think that you are required to know about alternating currents, impedances, and wave frequency, but you just need to properly understand how to create a graph and interpret it correctly.

Anyway, if you want to know more about alternating current, take a look at:

https://www.areatecnologia.com/corriente-continua-alterna.htm

Draw a line graph with the two data series (test and theoretical values).

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Even if you don't understand electronics perfectly, you will see that the maximum value on the *y* axis of the test values is smaller than the theoretical one, so we can state (even without knowing the cause) that the real voltage is smaller than it should be.

PILL 4 – ANALYZNG A SET TO DEFINE ITS PARTS

In your technology company, your boss needs to 3D-print an exact model (identical to the real one) of the mechanical assembly shown in the image, which you also have physically at your disposal. Through 3D software, he intends to make a 3D recreation of the assembly with such a level of accuracy that allows him to carry out thermal and mechanical tests in virtually.

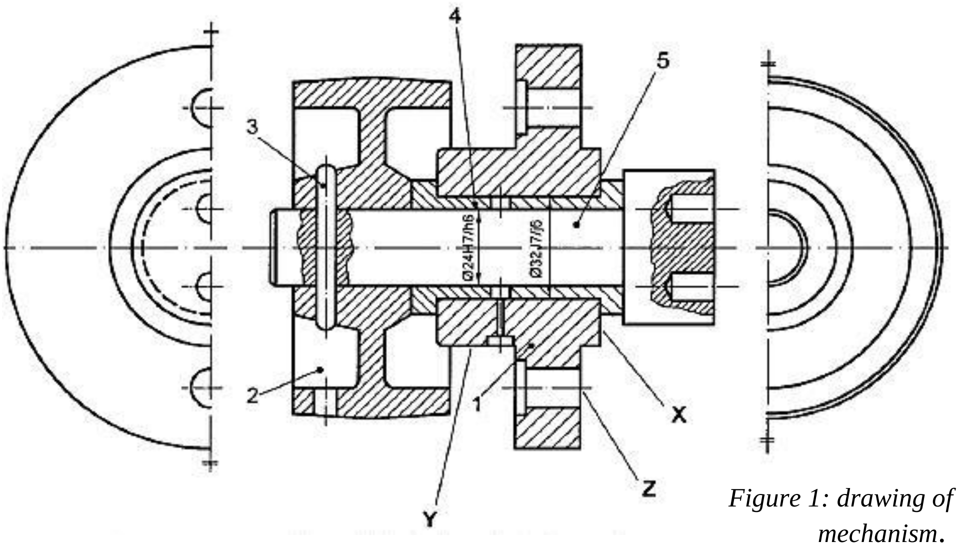


Figure 1: drawing of the full mechanism.

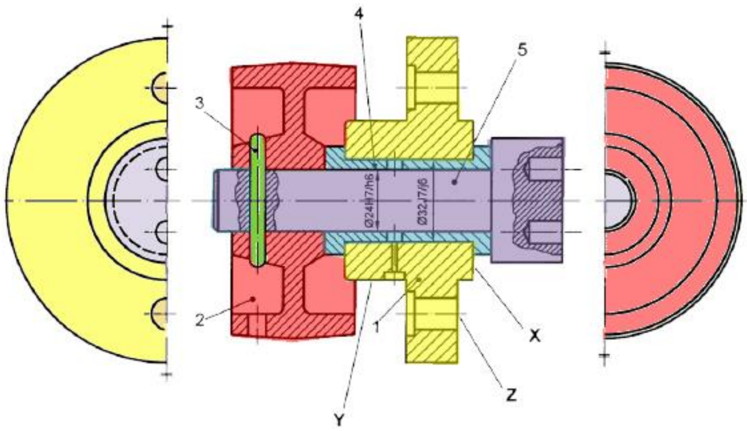
What would you have to develop so he could do this?

5	1	axis		steel
4	2	sleeve		bronze
3	1	bolt		steel
2	1	sheave		casting
1	1	body		casting
marking	**nº of pieces**	**designation and observances**	**norm**	**material**

HELP

Note that your boss not only asking you to define all the pieces that make up the assembly (a full breakdown), but also how they are all assembled and related. To do this, you will require several graphic documents, like an explosion diagram and a view plan of each of the pieces.

In order to draft the explosion plan, you must first perfectly understand each of the pieces of the set and how they are assembled, establishing the assembly order. Take a look at the attached image of how it is divided:



To carry out the complete breakdown (defining each of the pieces), you'll have to draft a blueprint of each of them under the criterion of economy of views; no dimensions are needed, just draw the pieces so that your boss has enough information to draw them. Just one tip: take a good look at the image in the statement… the answer is closer than you think.

FINAL REMARKS

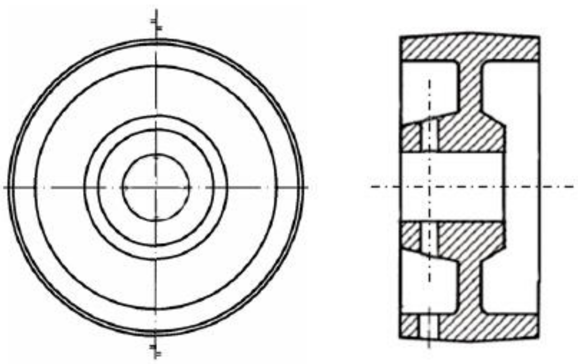
If you can solve this exercise, you will have used your critical and scientific analysis capabilities, since as you will have discovered, the creation of an explosion diagram requires not only drawing the different pieces that compose something, but also understanding how they work within the set and the role each of them has in it. An explosion diagram requires you to build the piece in your mind, to "see" how it works, and in what sequence to assemble each piece to assemble the full set.

Once you have generated the explosion diagram, you should have a 3D model of the piece in your mind, something similar to what your boss will do in a PC, but in a more intuitive and less exact way. What you need now is to turn this 3D model into three views at most: how the piece looks when viewed from the front (front), from its side (cross-section), and from above (elevation). If you can fully define the piece with fewer than three views, do so. In order to recreate each of the pieces, pay close attention to the overall drawing, because it already shows the three views of all pieces.

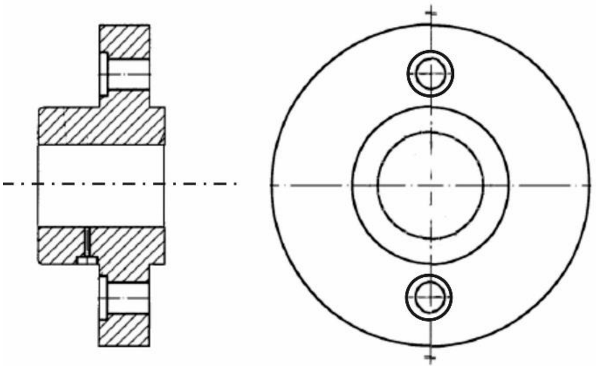
This is NOT an easy exercise, but if you solved it, you have managed to develop some much-needed skills in the technology sector, and also a capability for analysis that will be useful for you in many job decisions and requirements that you come across.

Once you have this exploded drawing, you just have to go back to the image of the statement because this is a three-view blueprint (elevation, right cross-section and left cross-section) of the whole set; in other words, it is a blueprint of all pieces once assembled. If you manage to isolate from it each of the pieces, you will automatically get their 3 views. The drawing in Help 2 should be very useful for you:

Piece 2

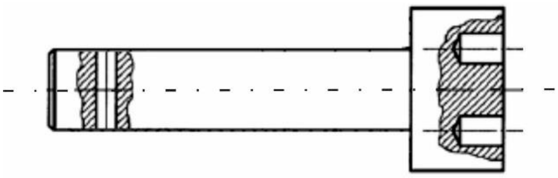


Piece 1



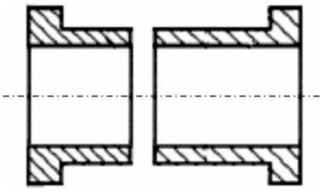
Piece 5

If you dimension correctly (state the size of each diameter) only one view is necessary.



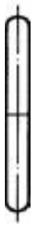
Pieces 4 and 6

These are two sleeves that are mounted on and trapped by the rest of the pieces. As in the previous case, a single view of the pieces should suffice if done correctly:



Piece 3

It is just a bolt.



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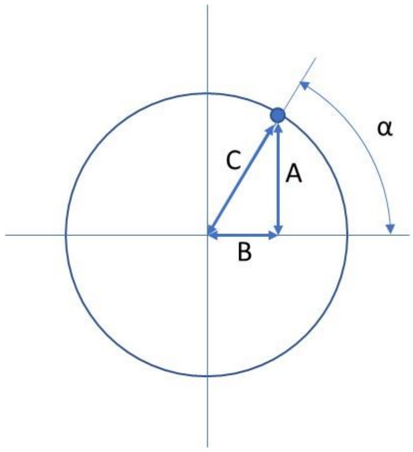
AREA 3: BASIC TECHNOLOGIC TRAINING FOR EMPLOYABILITY
D.U.5 – GRAPHICAL REPRESENTATIONS: very useful tools for the display and analysis of the results of a test.

PILL 1 – SOME TRIGONOMETRY

The trigonometric functions of sine, cosine, and tangent of an angle α are defined in reference to the drawing in Figure 1.



$sen\alpha = \frac{A}{C}$ $\quad cos\alpha = \frac{B}{C}$ $\quad tan\alpha = \frac{sen\alpha}{cos\alpha} = \frac{A}{B}$

α can be measured in degrees (the full circle is 360º) or in radians (the full circle is 2π radians).

These functions appear in many applications; let's see oscillatory movement as an example: the sine and cosine functions transform something that is continuously moving into an oscillatory motion. Imagine that a mobile object (the blue dot in Figure 1) is traveling along the circle at a speed of ω radians per second. When the object moves increasing the value of α, the cosine of the angle B/C goes from being 1 when α = 0, 0 when α = π/2, -1 when α = π, again 0 when α = 3π/2, and again 1 when the lap is completed at α = 2π.

Write the function of the cosine of the angle that marks the position of the object as a function of time *t* in seconds if the angular velocity of rotation (ω) is = $1s^{-1}$ and at time *t* = 0 it is at angle $\delta = \pi/4$.

Draw a diagram of this function; on this diagram, draw another one for initial position $\delta = \pi/10$.

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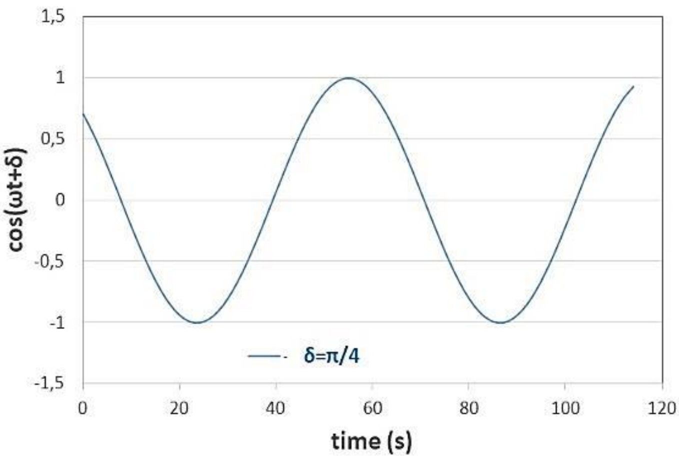
HELP

	B	C
5	ω	0,1
6	δ	0,78539816
7	delta t	2
8	t (s)	cos(ωt+δ)
9	0	0,70710678
10	2	0,55253129
11	4	0,37592812
12	6	0,18433789
13	8	-0,01460132
14	10	-0,21295842
15	12	-0,40282553
16	14	-0,57663327
17	16	-0,72745245
18	18	-0,84927041
19	20	-0,93723063
20	22	-0,98782642
21	24	-0,99904069
22	26	-0,97042636
23	28	-0,9031242
24	30	-0,79981732
25	32	-0,66462425
26	34	-0,50293471

The equation they ask you for is: $y = f(t) = cos(\omega t + \delta)$, y=f(t)=cos(ωt+δ) where *y* = *f(t)* is the variable that depends on time. For each time *t*, the angle the object has traveled is *ωt*, and to that you must add *δ*, which is the initial angle. You can create the graph in a spreadsheet.



In the data table, cells C5 and C6 have the values for *ω* and *δ* respectively (C6 is = PI()/4. Edit the function in cell C9 by writing = COS(C$5·$B9+C$6).

Notice the $ symbols; when copying cell C9 into C10, you'll see that the numbers that do not have the $ in front of them increase by one unit, but the numbers that do have it remain fix. Cell B9 has the initial value for time (0), and to B10 you add the amount we want to build the table values of *t*, by writing = B10+$C$7

C7 is = 2, meaning that the table of time values we are building grows each time by 2 seconds; if you are curious, you can change this value and see how the graph changes.

You just have to copy cells B10 and C10 down as many times as needed. The table shows only until the value of *t* = 34s, but the graph is drawn with values up to *t* = 120s. Figure 2 shows oscillation.

	B	C	D
5	ω	0,1	0,1
6	δ	0,78539816	0,31415927
7	delta t	2	2
8	t (s)	cos(ωt+δ)	cos(ωt+δ)
9	0	0,70710678	0,95105652
10	2	0,55253129	0,87070651
11	4	0,37592812	0,75564417
12	6	0,18433789	0,61045669
13	8	-0,01460132	0,44093223
14	10	-0,21295842	0,25382919
15	12	-0,40282553	0,05660679
16	14	-0,57663327	-0,14287235
17	16	-0,72745245	-0,33665563
18	18	-0,84927041	-0,5170175
19	20	-0,93723063	-0,67676752
20	22	-0,98782642	-0,80953695
21	24	-0,99904069	-0,9100327
22	26	-0,97042636	-0,97424832
23	28	-0,9031242	-0,99962373
24	30	-0,79981732	-0,9851473
25	32	-0,66462425	-0,93139615
26	34	-0,50293471	-0,84051318

Drawing the diagram with a new value for δ with those edited equations is very easy: just copy column C into column D, and change the value of δ in the corresponding cell, to stand as in the following table. Figure 3 shows the new curve. As δ increases, the curve shifts to the right, why?

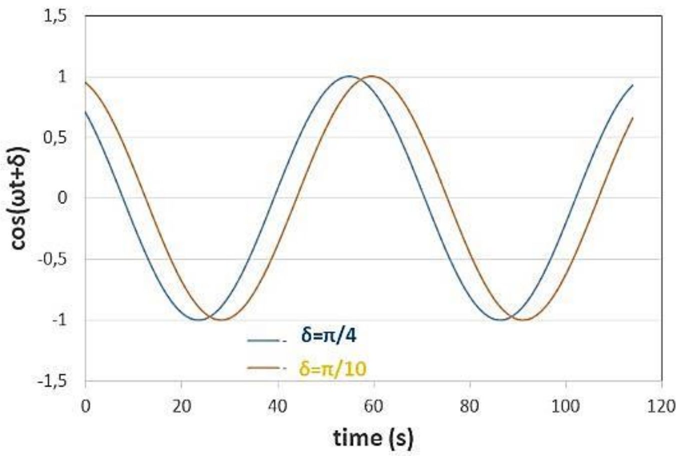


Figure 3: function $\cos(\omega t + \delta)$ with two different starting values.

FINAL REMARKS

The sine function behaves in a way that is analogous to the cosine function; you can easily see it in the spreadsheet. These are the characteristic functions of oscillatory movements, applicable in mechanical oscillators, in alternating electric current, in electromagnetic waves, and others.

PILL 2 – DATA DIAGRAMS

Different physical properties of substances in solid, liquid, or gas state are drawn as graphs or collected in tables. The following table collects data on the specific volume (v) of water as a function of temperature (T) and pressure (P) in liquid (gray background cells) or vapor state (white background cells).

For example, if you look for the value for the specific volume for P = 0,4bar and T = 120ºC, it is easy to find that v = 4,5144m^3/kg. But it will not always be that easy. Usually, pressure and temperature values are not exactly one of those listed in the table, in which case you will have to linearly interpolate between the closest data.

Find information on the concept of linear interpolation and calculate the specific volume for water vapor at P = 0,36bar and T = 220ºC. Up to what temperature must water be heated at 1bar to have density (ρ) = 0,98kg/l ?

Volumen específico (m^3/kg)												
		Presión (bar)										
		0,2000	0,3000	0,4000	0,5000	0,6000	0,7000	0,8000	0,9000	1,0000	1,2000	1,4000
Temperatura (ºC)												
0		0,001000	0,001000	0,001000	0,001000	0,001000	0,001000	0,001000	0,001000	0,001000	0,001000	0,001000
20		0,001002	0,001002	0,001002	0,001002	0,001002	0,001002	0,001002	0,001002	0,001002	0,001002	0,001002
40		0,001008	0,001008	0,001008	0,001008	0,001008	0,001008	0,001008	0,001008	0,001008	0,001008	0,001008
50		0,001012	0,001012	0,001012	0,001012	0,001012	0,001012	0,001012	0,001012	0,001012	0,001012	0,001012
60		7,6539	0,001017	0,001017	0,001017	0,001017	0,001017	0,001017	0,001017	0,001017	0,001017	0,001017
80		8,1159	5,3997	4,0470	0,001029	0,001029	0,001029	0,001029	0,001029	0,001029	0,001029	0,001029
100		8,5819	5,7128	4,2799	3,4190	2,8453	2,4352	2,1265	1,8872	1,6978	0,001044	0,001044
120		9,0468	6,0238	4,5144	3,6074	3,0034	2,5717	2,2472	1,9953	1,7940	1,4910	1,2744
140		9,5107	6,3338	4,7479	3,7948	3,1602	2,7062	2,3659	2,1010	1,8883	1,5707	1,3440
150		9,7431	6,4888	4,8646	3,8880	3,2393	2,7811	2,4239	2,1532	1,9364	1,6109	1,3784
160		9,9747	6,6446	4,9803	3,9813	3,3161	2,8396	2,4827	2,2052	1,9835	1,6500	1,4118
180		10,4386	6,9546	5,2137	4,1675	3,4713	2,9740	2,6004	2,3101	2,0776	1,7286	1,4796
200		10,9024	7,2634	5,4453	4,3541	3,6280	3,1074	2,7172	2,4140	2,1709	1,8071	1,5472
220		11,3663	7,5724	5,6776	4,5395	3,7829	3,2399	2,8339	2,5181	2,2650	1,8856	1,6148
240		11,8292	7,8822	5,9092	4,7258	3,9379	3,3733	2,9505	2,6211	2,3582	1,9631	1,6815
250		12,0606	8,0363	6,0257	4,8180	4,0155	3,4399	3,0084	2,6730	2,4044	2,0023	1,7149
260		12,2920	8,1903	6,1415	4,9112	4,0930	3,5065	3,0664	2,7250	2,4514	2,0415	1,7483
280		12,7549	8,4993	6,3739	5,0965	4,2470	3,6390	3,1829	2,8281	2,5446	2,1190	1,8151
300		13,2170	8,8091	6,6054	5,2827	4,4020	3,7722	3,2987	2,9311	2,6377	2,1965	1,8817
320		13,6790	9,1178	6,8361	5,4689	4,5561	3,9046	3,4146	3,0348	2,7301	2,2749	1,9484
340		14,1409	9,4258	7,0677	5,6552	4,7109	4,0371	3,5311	3,1381	2,8241	2,3525	2,0160
350		14,3723	9,5798	7,1834	5,7473	5,0745	6,3407	3,5889	3,1891	2,8703	2,3916	2,0486
360		14,6027	9,7338	7,2990	5,8396	4,9050	4,3937	3,6477	3,2412	2,9173	2,4299	2,0818
380		15,0646	10,0418	7,5305	6,0248	5,0191	4,3028	3,7634	3,3438	3,0085	2,5064	2,1476
400		15,5265	10,3498	7,7628	6,2104	5,1747	4,4344	3,8792	3,4469	3,1017	2,5839	2,2142
420		15,9847	10,6577	7,9933	6,3948	5,3287	4,5667	3,9949	3,5497	3,1938	2,6604	2,2799
440		16,4457	10,9657	8,2248	6,5801	5,4828	4,6989	4,1098	3,6528	3,2870	2,7380	2,3465
450		16,6715	11,1197	8,3404	6,6725	5,5610	4,7647	4,1678	3,7046	3,3332	2,7770	2,3791
460		16,8974	11,2737	8,4561	6,7648	5,6385	4,8313	4,2256	3,7557	3,3792	2,8153	2,4123
480		17,3584	11,5815	8,6867	6,9499	5,7915	4,9628	4,3415	3,8593	3,4715	2,8928	2,4789
500		17,8193	11,8894	8,9171	7,1343	5,9455	5,0952	4,4571	3,9616	3,5645	2,9693	2,5447
520		18,2803	12,1974	9,1486	7,3196	6,0996	5,2276	4,5728	4,0645	3,6568	3,0467	2,6106
550		18,7412	12,5052	9,3790	7,5038	6,2526	5,3591	4,6883	4,1668	3,7499	3,1244	2,6780
540		18,9763	12,6592	9,4947	7,5960	6,3291	5,4249	4,7463	4,2186	3,7960	3,1627	2,7113
560		19,2207	12,8131	9,6094	7,6872	6,4055	5,4896	4,8033	4,2696	3,8422	3,2017	2,7438
580		19,6816	13,1210	9,8398	7,8717	6,5564	5,6054	4,9188	4,3717	3,9343	3,2782	2,8096
600		20,1425	13,4280	10,0703	8,0561	6,7134	5,7535	5,0346	4,4748	4,0275	3,3558	2,8762
620		20,6035	13,7359	10,3016	8,2403	6,8666	5,8859	5,1503	4,5778	4,1207	3,4341	2,9430
640		21,0644	14,0438	10,5322	8,4257	7,0213	6,0173	5,2650	4,6799	4,2130	3,5116	3,0097
650		21,2995	14,1978	10,6479	8,5179	7,0979	6,0839	5,3230	4,7317	4,2591	3,5500	3,0431
660		21,5253	14,3508	10,7626	8,6100	7,1745	6,1496	5,3808	4,7828	4,3051	3,5883	3,0763
680		21,9863	14,6588	10,9941	8,7953	7,3283	6,2810	5,4955	4,8848	4,3973	3,6647	3,1411
700		22,4472	14,9666	11,2245	8,9797	7,4824	6,4134	5,6112	4,9877	4,4894	3,7410	3,2059

HELP	
HELP	The pressure value for which you have to find the specific volume is not in the table. To understand what it means to interpolate linearly, you can draw specific volume as a function of temperature at 220ºC, as seen in Figure 1. Clearly specific volume does not depend linearly on temperature in the pressure range between 0,2 and 1,4bar. Linear interpolation is an approximation, so you can accept the value approximately between the two points closest to which what we want to calculate. The relation v(P) in this case can be represented as a straight line to look for the middle point, as seen in the detail of Figure 1 with a red line.

Specific Volume of water at 220ºC

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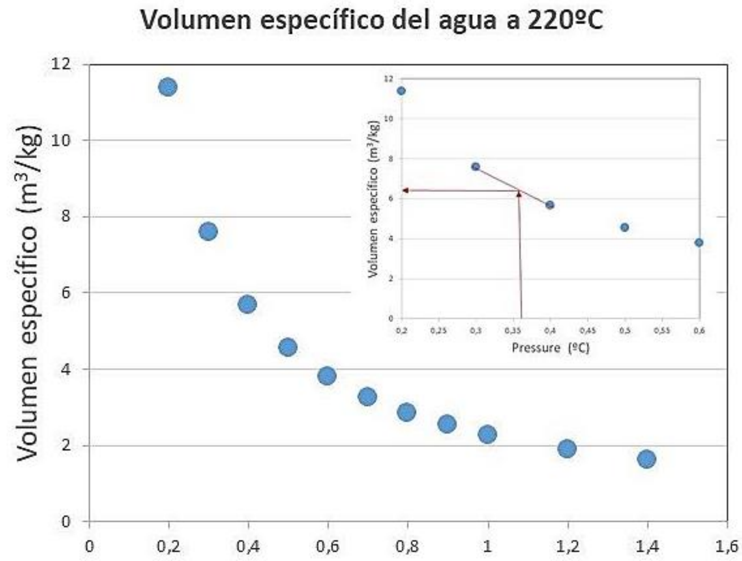


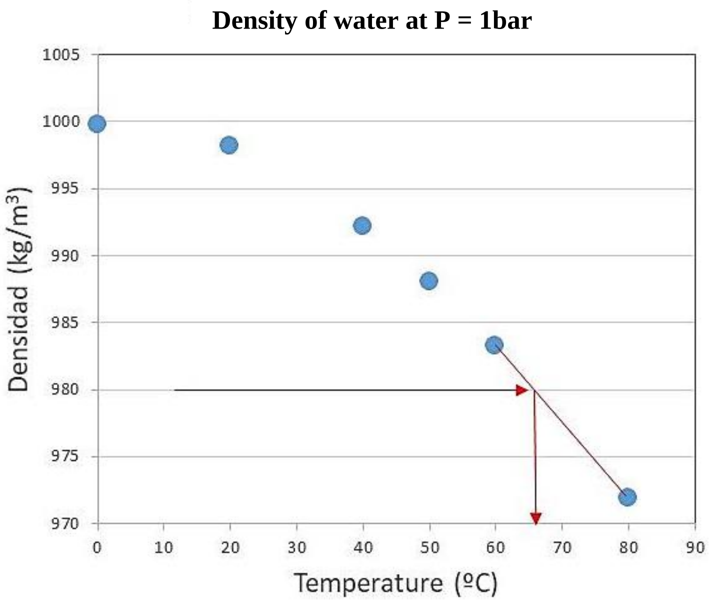
Pressure (bar)

The equation of this line is determined by the two end points, p_1 = 0,3bar, v_1 = 7,5724m^3/kg and p_2 = 0,4bar, v_2 = 5,6776m^3/kg.

The line will have the generic expression: $v - v_1 = B(p - p_1)$. Find the equation of a line that passes through two given points; B is the slope of the line: $B = \frac{v_2 - v_1}{p_2 - p_1}$

Thus, in our case: $v = 7{,}5724 + \frac{5{,}6776 - 7{,}5724}{0{,}4 - 0{,}3}(p - 0{,}3)$

Substituting the value of p = 0,36 bar we get: v = 6,436 *m³/kg*.



In the second part of the exercise, the interpolation is the inverse: you have to find the temperature knowing pressure and density (the inverse of specific volume). To understand this, represent density as a function of temperature for pressure = 1bar (Figure 2). The two points closest to The densities in the table are:

$T_1 = 60ºC$ → $\rho_1 = 1/v_1 = 983{,}28 kg/m^3$,

$T_2 = 80ºC$ → $\rho_2 = 1/v_2 = 971{,}91 kg/m^3$.

With the calculation from before, you get that for T = 65,8ºC , $\rho = 980 kg/m^3$.

FINAL REMARKS

Linear interpolation, as we have said before, introduces an error that is greater the more the function to work with deviates from linearity. There are more complicated adjustments to be more accurate: for example, the curve in Figure 1 could be fitted to a polynomial function (the spreadsheet software can also do this).

Figure 3 shows that you can fit your data for specific volume at T = 220ºC to a potential equation (the spreadsheet software has several types of them, find the one that fits you best), which would be $v = 2{,}2649p^{1{,}003}$. There, if you substitute with p = 0,36bar, you get v = 6,311m^3/kg. Considering that this is the most correct value, and comparing it with the value found with linear interpolation, the error was of: $error = \left|\frac{6{,}311-6{,}436}{6{,}311}\right| 100 = 2\%$

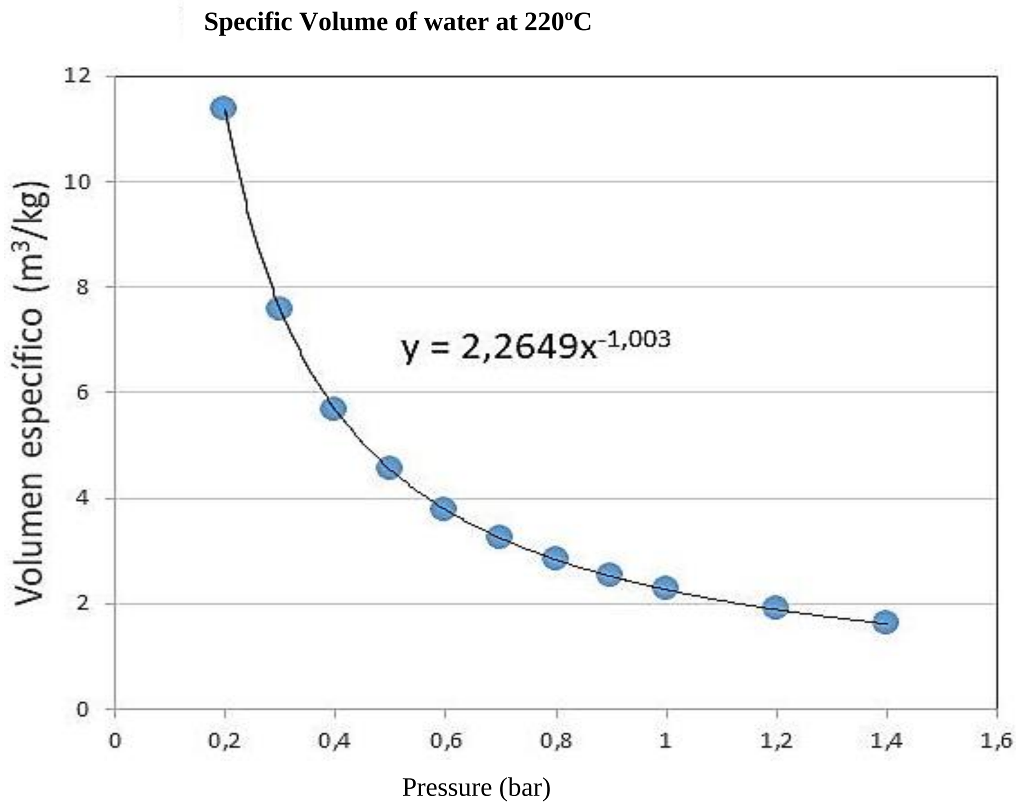


Figure 3: potential equation adjustment.

PILL 3 – PERSPECTIVE DRAWING

Drawing a piece in cavalier perspective (parallel oblique projection) can give you a clear idea of its shape and help you quickly explain to another person what you want to do using a hand-drawn sketch, although more precise ways of representation will probably be needed later when defining the manufacture of that piece.

Let’s see how to draw a piece in perspective, defined by its front, elevation, and lateral profile in a dihedral system. If you haven’t seen these representation systems before, look for information about them, you will find that understanding cavalier perspective is a matter of a few minutes, but assimilating all its details may take longer. Take a look in particular at the orientation of the depth axis and what the reduction ratio means.

Figure 1 defines a piece in dihedral system. Make an approximate drawing of this piece in cavalier perspective, with the axes represented in Figure 2 and with a reduction coefficient of ½. We’ve drawn a cube in Figure 2 as a guide.

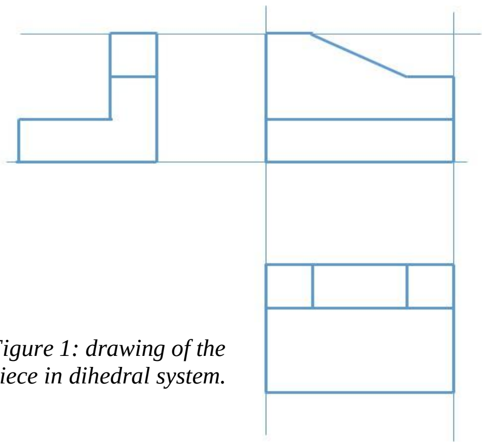


Figure 1: drawing of the piece in dihedral system.

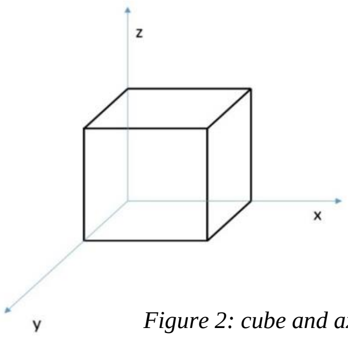


Figure 2: cube and axes.

HELP

You can to start by representing the piece’s elevation profile on the *z-x* plane. In cavalier perspective, representations in the *z-x* plane are made with in true size, meaning you just have to copy the elevation in any position (we have set it on the coordinate origin). The front is distorted according to the angle of the *y* axis (the depth axis) and the distances on it are affected by the reduction coefficient. In this case, those are ½ the size of the measures in the dihedral diagram.

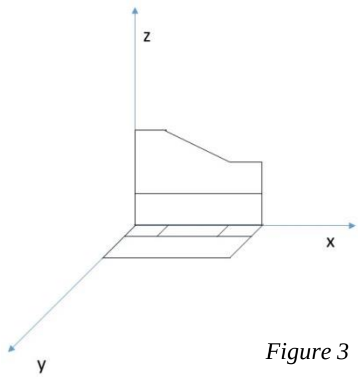


Figure 3

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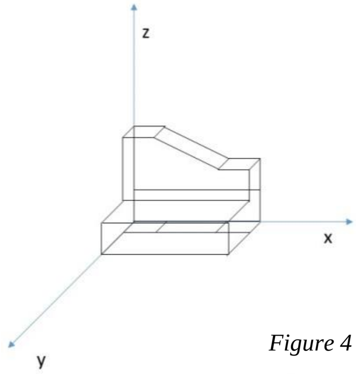
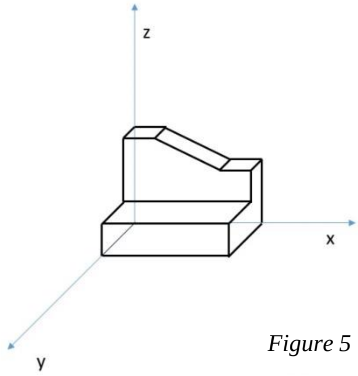
	Now, continue drawing a spatial image of the piece build the rest of the surfaces.	 *Figure 4*
	Several lines are actually hidden due to perspective. Highlight those that are visible and erase the hidden ones.	 *Figure 5*

FINAL REMARKS

The figure that we propose in this example is quite simple (for example, it has no nooks or crannies); in the dihedral system drawing, the piece is perfectly defined without the need to use hidden lines or separate sections. If you are interested in delving further into these representation systems, you can find countless exercises of this type online, with which you can continue to gain experience.

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PILL 4 – DIMENSIONING

In the previous pill you made an approximate three-dimensional drawing of the piece sketched in front, elevation, and lateral profile in the dihedral system. You did probably have the doubt of how to know the exact size of each part of the piece. These dimensions cannot be measured on a blueprint or sketch: instead, a dimension must be set for each length or size of interest.

In this pill, we are going to dimension the piece of the previous pill. Figure 1 is the same sketch of the piece in the dihedral system, but we have specified a dimension for one of the lengths. Deduce the rest from it by measuring on the drawing itself.

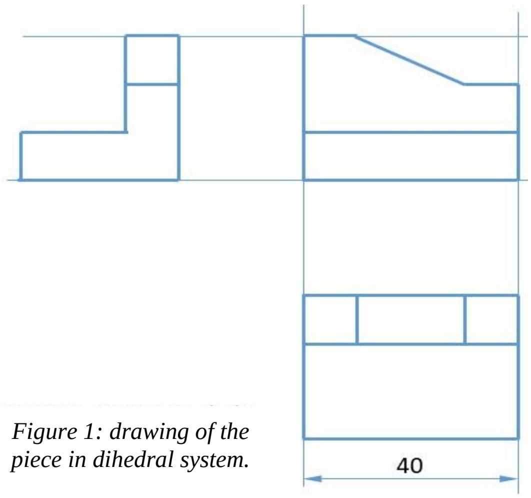

Figure 1: drawing of the piece in dihedral system.

HELP	Dimensions are always written in millimeters (mm). Look online for the basic rules for dimensioning, you will find that there are some essential rules, like dimensioning the full sizes of the piece, you don't have to add partial dimensions to get totals, the piece must be completely defined (in this exercise you have to measure on a blueprint; once the part has been dimensioned, it shouldn't be necessary to do anything else). You shouldn't repeat dimensions, for example, also not place a dimension on a distance that appears already both in the elevation and in the profile. Other rules are more of an aesthetic nature, like to give clarity to the plan, making numbers be able to be read from below and from the right, placed on the dimension, writing the dimensions outside the drawing of the piece as much as possible, dimensions not intersecting the lines that define the piece, and intersect one another.

Some examples of dimensions that should be placed differently, what's wrong with dimensions A, B and C?

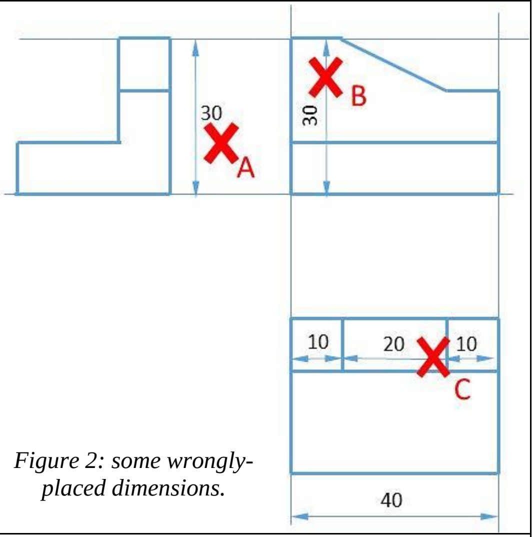

Figure 2: some wrongly-placed dimensions.

In dimension A of Figure 2, the number should be rotated and on the dimension line itself, as shown in Figure 3. Also, that dimension is sizing the same length as dimension B, so leave just one of both. Dimension B was inside the drawing and cutting one of its lines, it must be placed outside. Dimensions C must also be placed outside of the drawing. Although dimensions C add up to the 40mm of the dimension located at the bottom, this is not considered a repetition, since dimension totals are very useful in manufacturing and is usually always specified.

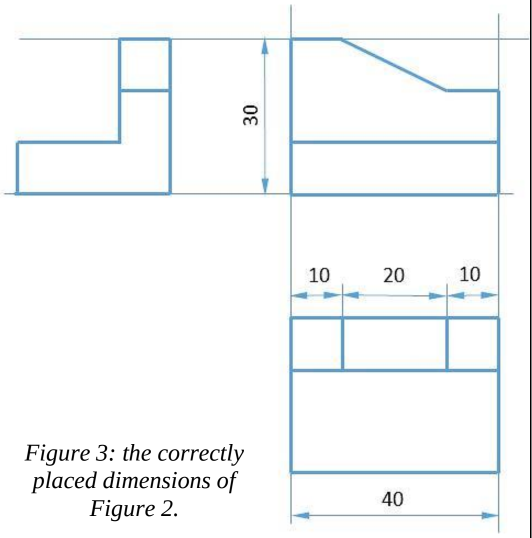

Figure 3: the correctly placed dimensions of Figure 2.

FINAL REMARKS

Figure 4 shows the dimensioned piece. Of course there are different ways of doing it, it does not have to match yours, but reflect on why this one is done like this and compare it with your version.

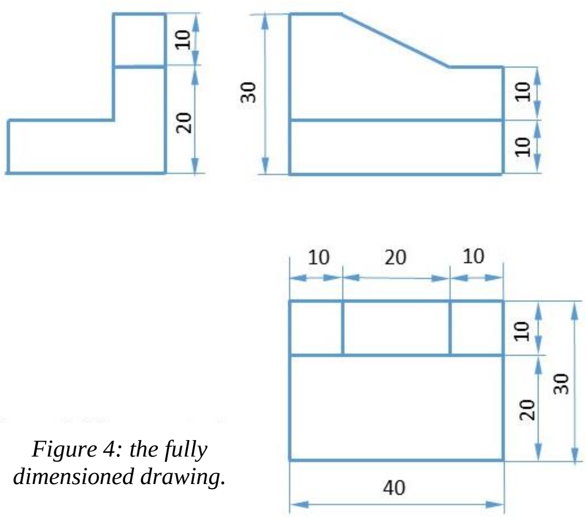

Figure 4: the fully dimensioned drawing.

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AREA 3: BASIC TECHNOLOGIC TRAINING FOR EMPLOYABILITY
D.U.6 – OCCUPATIONAL RISK PREVENTION: the set of measures that have to be taken in all stages of job activities with the objective of avoiding or minimizing risks derived from work.

PILL 1 – IN THE EVENT OF FIRE

The way to act before an accidental event is not something that can be left to intuition; occupational risk prevention requires preparation. The company you work for must have training on this for your workplace, with a specific section on risk identification and prevention. In any case, you can look for information on your own on those risks that you can identify, and prepare yourself on how you would act if an accident occurs.

The possibility of a fire, although remote, is present in any facility: business, commercial, or domestic. We have to note that acting in case of fire it is not as obvious as it seems; perhaps the first things that come to mind are not the most correct ones. The objective of this exercise is to look for indications on how to act and reflect on them.

As a source of information, visit the website of any large company or public body, like a university. All of them will state more or less the same things; write an ordered list of the actions to take in case of a fire in your company.

We suggest you the following: first, before reading anything, write what comes to your mind first when imagining the situation, and then take a look at what that information tells you to do. By contrasting with your first ideas, you will notice the possible mistakes and you will not forget what to do.

HELP	You'll probably find a more or less extensive series of indications, which may not match the first things that came to your mind. For example, the first thing they tell you to do is to call the emergency number: either the organization's, if there is one, or the general one, which in Europe is 112, and alert all people who may be in the building. The first thing that you maybe thought is to find the extinguisher and use it, but that comes later, once the situation is analyzed, to know if it is appropriate to used it. Of course, if there are people on fire, you have to attend anyone who may have their clothes on fire by using an emergency shower (if there is one) or throwing

	the person to the ground, roll them, and use clothes to try to smother the fire on them and put it out. The next step is -if you know how to use fire protection equipment (there are different types of extinguishers)- to value if you can act against the fire without putting yourself in danger. Otherwise you have to leave the building and go to the “Meeting Point”. If you suspect toxic smoke is being released, leave the building immediately. Fire extinguishers should only be used at the beginning of the fire and from a position that allows you to escape if necessary. When evacuating the premises, close all doors.
	What questions come to your mind about the protocols you have read? Think about them before a probable training course in occupational risk prevention.

FINAL REMARKS

The protocols of action in case of emergency -precise and undoubtedly well thought out instructions on what to do- should not induce you to accept them without reflecting on them.

There is not much time to think in these situations, so it is necessary to have previous training and time to reflect on the reasoning behind the different instructions. Ask yourself how you can act against fire without putting yourself in danger, why they ask you to go to a meeting point when leaving the building, or why they ask you to close all doors when leaving.

Do you know the meeting point for cases of evacuation of your vocational training center or company?

PILL 2 – COVID-19 PREVENTION MEASURES

The measures intended to stop the spread of the SARS-CoV-2 coronavirus, the cause of the COVID-19 pandemic, have evolved over time.

We need to accept that, at the beginning of the progression of its spread, when very little was known about this virus, measures were established based on previous existing knowledge about other coronaviruses, or on the reaction to pandemics throughout history. As of December 2021, more than a year and a

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half after the spread of the pandemic to Europe, some of these measures are still in force, and others are currently less emphasized or are being criticized.

Which contagion prevention measures do you think are the most appropriate now? Look for an example of a scientific discovery that changed the viewpoint we originally had about the means of transmission of the virus.

HELP	Look for the measures established in your learning center or your company, in addition to those in force in your city.
	You might remember that several months after the start of the pandemic, the role of airborne suspended particles in the transmission of the virus was better known, since it was discovered that it lingered in the air longer than originally thought, so expulsion of particles into the air when breathing or speaking was considered the main source of transmission. Proper indoors ventilation became essential, and outdoors meetings were less dangerous than indoor ones. At that point, we also discovered that transmission through surfaces had a very small incidence, but it was given much more importance at first.
	Do you doubt that widespread vaccination is essential to stop the pandemic?

FINAL REMARKS

This issue is something that everyone has grappled with in one way or another; everyone took a position on the different prevention measures the authorities were adopting and imposing based on the evolution of the disease and new scientific knowledge. The amount of information has been enormous, many times with interests in one or other ways, and many times with falsehoods or half-truths.

Reflect on how we formed our ideas about the pandemic and took a position on the measures imposed. Were we really thoughtful on those points? What we thought was the result of our reasoning, or was it more in line with what we were interested in thinking? We often accept some reasoning as true because it justifies what we are interested in doing and leaves us be, and other times we just accept the reasoning of others in which we place our trust without evaluating it ourselves.

PILL 3 – CHEMICAL REAGENT SAFETY DATA SHEETS

You are going to use methyl ethyl ketone (MEK) as a solvent. Look for its safety data sheet and see if you understand its contents. Write a short summary in your own words of what you consider most relevant for handling this reagent: why is it toxic, what personal protection items do you have to use when working with it, the ventilation requirements, its storage requirements…

HELP	Safety data sheets (SDS) can be found at the website of any reagent supplier, so visit the website of a chemical supply company and you'll be able to download the safety data sheet on your language, along with the characteristics of the product and its price.
	Note that the toxicity of the reagent determines its conditions for storage and use: if you need to handle it under an extraction hood, the type of gloves you must use, if it is necessary to wear a gas mask and of which kind…

FINAL REMARKS

The safety sheets of the products handled by a company must be collected and available to its workers. The company must have its own procedures to keep said file updated and to train its workers before using any product. One cannot handle a reagent, as one cannot handle a machine, without prior training.

PILL 4 – REGULATIONS ON THE STORAGE OF REAGENTS

Your company uses acetone for different processes. Its hazard warning codes are H225, H319, H336. What do these codes mean? And, from them, how must acetone be stored and what is the maximum amount of it that can be stored in a company without specific facilities and safety checks?

HELP	Identification lists of hazard warning codes can easily be found on websites, but perhaps it is simpler to go directly to the safety data sheet, which will precisely define all the chemical's risks.

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	There are clear regulations for the storage of chemical reagents; in Spain, Royal Decree 656/2017, of June 23rd, which is adapted to European legislation, specifically to Regulation (CE) 1907/2006 of the European Parliament and Council on the registration, evaluation, authorization, and restriction of chemical substances and preparations (REACH); and to Regulation (EC) 1272/2008 of the European Parliament and Council on the classification, labeling, and packaging of chemical substances and mixtures.
	The regulation has strict specifications on the storage facilities for dangerous products; it establishes storage limits depending on the product's dangerousness that leaves companies that store smaller quantities outside these restrictions. However, even if the storage is below this limit, it is necessary to follow certain indications, such as those regarding the physical distance separating storage places for products that can interact with one another (like acids and bases), and the type of container to be used. There are standards of good laboratory practices published on these topics.

FINAL REMARKS

You can check out the "*NTP 725 standard of good practices: Laboratory safety: storage of chemical products*" of the National Institute of Work Safety and Hygiene from Spain's Ministry of Labor and Social Affairs, or its equivalent in other European countries. NTPs are guides of good practices whose indications are not mandatory unless they are included in a current regulatory provision.

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FROM LITERACY TO DIGITAL AND TECHNOLOGICAL TRAINING: INNOVATIVE AND CUSTOMIZABLE TRAINING ITINERARY TO FACILITATE THE EMPLOYABILITY AND INCLUSION OF ADULTS.