

# Bizkaia Tech

Hey, ChatGPT, could you sing me a bertso? | Issue 10



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**BizkaiaTech Magazine** Hey, ChatGPT, could you sing me a bertso? | Culture and STEAM  
Issue 10 - Fall 24

## Magazine

When we have answers we must change the questions. Only like this can we innovate disruptively. Change schemes, paradigms and ways of thinking.

**BizkaiaTech Magazine is the go-to magazine** (filled with art) for inquisitive minds, full of good ideas, great projects and good vibes.

**Born to share learning, with a disseminating spirit and the soul of an artist.**

With each change of season (winter, spring, summer and autumn) we get inspired, take a deep breath and capture it by launching a new issue.

We want to be the space where anyone, wherever they come from, can find the latest news in technology, great stories, projects that we are doing, projects that are to come and how to get the best out of our land, which belongs to everyone.

And all this, **collaborating with local artists.**

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# Culture built through a STEAM lens

BY BIZKAIATECH EDITORIAL TEAM / ILLUSTRATION NAHIA IGLESIAS (MARRABILA)

The world we live in doesn't stop. Time seems to slip through our fingers, and culture, caught in the rush, often seems to blur. Today's pace, driven by the speed of information and technology, has fundamentally changed the way we interact with our surroundings and, above all, with each other. Technology undeniably gives us new tools to share and create, yet it also speeds up cultural consumption and virtualizes our relationships. Shared experiences now often feel shallower than they once did, when they connected us more genuinely to our culture.







In this fast-paced environment, we ask ourselves: have we lost something culturally in the process? Has so much connected time also meant disconnection from what's authentic and communal?

But let's look at it from another perspective: technology not only changes the way we consume and share culture, it also revitalizes and expands it in unexpected ways. Technology democratizes culture, too. Through STEAM and similar approaches, culture is finding new avenues to express itself and reach more people. Far from disappearing, culture remains vibrant and evolving, demonstrating an exceptional ability to adapt and thrive in this digital age.

## Has so much connected time also meant disconnection from what's authentic and communal?

In this issue (our tenth one already!) of BizkaiaTech Magazine, we'll explore culture in its many forms through a STEAM lens. We'll cover the standout annual gathering that merges local culture, dive into classic literature, lay out the green tapete for a game of mus, and warm up our voices for some singing.

*Spoiler alert:* we're going to propose a theme, a measurement, and a rhyme pattern to both a well known *bertsolari* and ChatGPT. Who will win?

We're sharing this ahead of time in case you're already missing the pure BizkaiaTech spirit!

### SCIENCE AS A BACKDROP

We'll explore the impact of the internet and social media on the music and literary industries and how they've also shaped one of the must-attend events of *euskal kultura*: Durangoko Azoka.

We'll take a misty morning trip to London to see how cryptography and literature come together and help Sherlock Holmes solve a murder-related mystery.

In its classical sense, culture has a lot to do with mathematics, too; they're present in the *euskal dantzak* and can even be part of a game of mus. In traditional dances, math comes into play with the rhythmic adaptation of music, where beats measure sound duration in mathematically organized intervals. And chance—closely tied to the mathematical concept of probability—can help us understand how winning a card game involves calculated, informed decisions.

### TECHNOLOGY AS A TOOL

Some games are a fundamental part of our culture in Bizkaia. Think of *tabas* or *txokor batze*. With the rise of the internet and the shift from analog to digital, the way these traditions are passed on has evolved. At Estudio Relevo, Jon Cortázar and his team are creating digital games that nod to traditional culture.

Our way of consuming content and entertaining ourselves has changed, too. Many generations were glued to the TV watching cartoons in Basque on those long summer mornings (especially rainy ones, when trips to the beach or outdoor play were less likely). Now, amid the avalanche of content, faster plots, and less available time, binge-watching has taken over, a true sign of our times.

This edition of BizkaiaTech Magazine aims to highlight some of the most rooted aspects of Bizkaia's culture. We'll discuss Athletic Club and how this football team uses technology to improve performance (could their latest cup victory have had something to do with it?) as well as the modernization of one of the most traditional and economically impactful professions in our culture: fishing.

## Far from disappearing, culture remains vibrant and evolving, demonstrating an exceptional ability to adapt and thrive in this digital age

Technology can be an excellent ally in creating and disseminating culture in any form, but it will never replace human creativity and sensitivity. Culture is something we build, shape, and keep alive; it reflects our identity and history, something generative artificial intelligence can't replace. Culture arises from the deepest parts of our essence and our shared experiences.





# BEÑAT GAZTELURRUTIA AND THE PLEASURE OF SEEING EACH OTHER AT THE DURANGOKO AZOKA

BY BIZKAIATECH EDITORIAL TEAM / ILLUSTRATION ALBERTO MURIEL

Durango becomes the center of Basque culture throughout the December holiday weekend. This multi-day event, which brings together people of all ages, first opened its doors in 1965 at a porch in Durango, aiming to bring Basque culture (repressed by the dictatorship) closer to its neighbors. Today, despite many social and technological changes, the fair has evolved significantly, but the desire to keep Basque culture alive and thriving remains undiminished.





We talked about these changes with Beñat Gaztelurrutia, the coordinator of Gerediaga Elkarte, the association responsible for organizing Durangoko Azoka. He took the time to help us understand this beloved and important event from the inside. We discussed the beginnings of the fair, the changes it has undergone, new technologies, and its future. Here is what Beñat had to share. Would you like to get to know him better?

**BizkaiaTech Magazine: The first Durangoko Azoka was held in 1965 and remains a highly famous and important event to this day. An event that has lasted so many years must learn to absorb and adapt to societal changes (technology, legislation, the Internet, format changes). How do you handle these changes? How has the fair evolved into what it is today?**

**Beñat Gaztelurrutia:** Durangoko Azoka will celebrate its 60th anniversary in 2025, and the changes it has undergone over six decades have been immense. In terms of digitalization, we've only seen the revolution it brought in the last two decades, but before that, the fair already had a four-decade trajectory. So, the fair's evolution can't be explained by digitalization alone, although it has had the most impact in recent years.

The first fair was put together by setting up some tables under the church. At that time, in 1965, the Basque cultural sector (publishers, record companies, creators, etc.) was completely disorganized. Consequently, to organize the first fair, they had to travel all over the Basque Country to convince people to come. That's where the journey of Durangoko Azoka begins.

Although we can't highlight every year, I would say there are two key milestones in the fair's journey. The first is the starting point we've just discussed: this project was created in a very disorganized time. It was an effort to unite the cultural sector, a demand for unity. Later, the sector began to organize itself, with organizations shaping public policies, bookstores opening, and Basque culture passing into the hands of the people. The second major change likely came with digitalization, bringing another milestone, not only in terms of organizing the fair but also in the cultural sector. This shift has also forced a redefinition of the fair itself. Although the organization is constantly evolving, I think these are the two most

## We want to build a community of people passionate about Basque culture



## The fair never starts or ends at a specific moment: it's a wheel that keeps turning

significant changes. Ultimately, the fair reflects the times we're in, and the organization must keep up with that.

**BTM: Speaking of these changes... How do you assess whether something has worked or not? Is this an all-year-round effort, or do you make decisions after observing people's reactions? What methodology do you use?**

**BG:** The fair never starts or ends at a specific moment; it's a wheel that keeps turning. We are constantly in contact with all the people and organizations involved in the fair. These are what we call participants: those who set up the fair, cultural producers, those who help us with presentations, organizations, and sponsors who financially support the event. We are constantly assessing things with all these parts to see what the fair can offer, and we adapt it based on that.

It's important for me to mention that Gerediaga Elkarte had to initiate this project in a historically significant moment when there was a historical need for education, evening schools (where adults could learn Basque), Euskara batua (unified Basque), and Basque songwriting. While we had to manage the organization and a national project at the time, this doesn't mean that Gerediaga decides what the fair should be. So far, we've created and carried out everything collectively, and we must continue down this path together. The association's role is to gather all the inputs and, in some cases, make decisions, but above all, our main task is to keep our ears open. From the proposals we receive and the evaluations we make, the fair evolves year after year.

**BTM: Do you recall a specific year when the fair underwent a drastic change?**

**BG:** Yes, the fair I know best is from recent years, and the change I remember most is the transformation from being just a market to a place where you can have a complete cultural experience. This shift was likely driven by the digitalization we discussed earlier. Today, it has become a place to discover culture, explore it, and attend presentations. It's not just a one-day plan anymore, it makes you want to come every day. I think that's the most important change we've seen so far.

**BTM: You've mentioned that digitalization has brought significant changes to the fair, not only in**







terms of organization but also in how people enjoy it from afar. How has the fair changed since we entered the digital age?

**BG:** The first thing that changed was the organization: in the beginning, they were only responsible for organizing the fair. In later years, a full catalog was created and published for those who wanted it. Today, in the current Durangoko Azoka, that entire process is done digitally. The entire process with the fair's participants (name registration, catalog creation, revisions) is also done digitally. We've developed a tool to streamline the digitalization process, where anyone who wants to set up a stall can submit their request. Once registered, we ask for everything needed to proceed through the same system, such as what they'll be selling and a photo. This way, we can show visitors what they can expect.

Digitalization has been with us from the start, from contacting the participants to managing relationships with those who will visit the fair. Our way of working has changed a lot.

Digitalization has also impacted the cultural sector, of course. When the digitalization phenomenon first emerged, the initial fear was what would happen to physical books, educational materials (which are also plentiful at the fair), music, audiovisuals, or video games. Each sector has responded differently and had to adapt. For example, it seems that literature has survived and the paper format has persisted, meaning readers still prefer paper over screens. Despite this sector's resilience, music, for example, hasn't been able to reinvent itself. Today, all music is free, and I don't think any band hesitates to put their work online (though they later sold physical copies).

The fair doesn't have a fixed response; everyone is doing what they can. Additionally, there isn't a collective effort in the sector to confront this because it's seen as an international phenomenon, and we'll just have to get used to it.

Before, you had to come to the fair to access the vast catalog we offered; it was the only way to see the new releases. Today, however, we display all the new arrivals digitally. So, why come to the fair in person? Well, beyond discovering titles and new releases, it allows you to meet the people behind your favorite book or album, talk to them, and hear what they have to say. To have this full experience, it has to be in person. The digital aspect

## Artificial intelligence, for now, won't outdo human creativity

can certainly help the fair, and while we strive to make the most of what it offers, being there physically is more necessary than ever. We want to build a community of people passionate about Basque culture.

**BTM:** When we talk about digitalization, we can't ignore another factor that has impacted the entire world in recent years: globalization. We see how culture tends to globalize more and more, and today, Basque culture is no longer just our own. For the fair, would you say this is an advantage or the opposite? How do you think this affects Basque culture?

**BG:** I would say globalization doesn't affect Durangoko Azoka much because we are a fair in a very specific place. However, it does affect Basque culture. Personally, I'm quite negative about this topic. It's true that globalization opens the door to other countries, but it also allows others to enter your home. Opening the doors should be a good thing, but in that journey, minority languages are the ones at risk. This isn't new, for example, when national markets were created (2-3 centuries ago), it became essential for people to understand each other, so a single language was necessary.

I don't know what will happen in the future, but globalization must also have its limits. In recent years, we've seen that the planet has limits. Only time will tell if, with the depletion of fossil fuels, we will turn to more local economies. Although nothing is certain, in that context, I think smaller languages may have opportunities. In a globalized world, I see more problems than opportunities, although I also believe that Basque culture needs to be open to the world. I think that only enriches us, but the downside is that it could lead to the disappearance of the language.

**BTM:** To conclude, we'd like to talk about the future of Durangoko Azoka. If technology continues to advance at the rapid pace we're seeing, societal changes seem more and more inevitable. Artificial intelligence, for example, has gone from being something people hardly talked about to being used daily. Considering this transformation, how do you see Durangoko Azoka in 10 years?

**BG:** The truth is, it's hard to imagine. You mentioned artificial intelligence, and I think we'll need to be very careful with it. Last year, the organization also used AI for our campaign, but we used it as a tool, in an innocuous

way. However, it's true that this tool poses a threat to human creation. There was recently a controversy where an author admitted to creating images and texts using AI, although he later made the corrections himself. I believe authorship needs to be vigilant about this and advocate for human creativity.

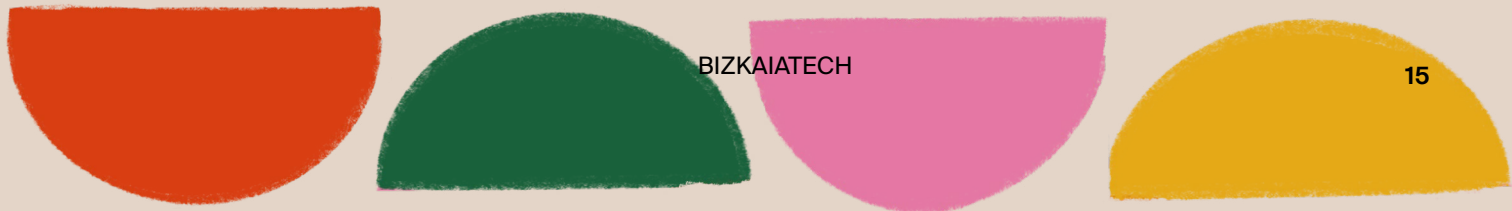
I don't know how much the world will change in a decade, but for now, Durangoko Azoka is a fair of authors and publishers, and everyone involved is very clear on that. I don't think the fair will be overtaken by these new technologies in the short term.

**BTM:** Thank you very much for your time, Beñat. If you don't mind, we'd like to end the interview with your final words.

**BG:** I'd just like to remind everyone that before the fair opens its doors, we make it available to people using all the tools and possibilities digitalization offers us. However, this digital fair will never replace the experience of attending the fair in person. **So... see you at the fair!**







# ENCRYPTED MESSAGES: MATHEMATICAL GAMES IN LITERATURE

BY MARTA MACHO STADLER (UPV/EHU) / ILLUSTRATION LAURA ARRUE

Mathematics is highly present in our daily lives. In the technological field, among other uses, it underpins the cryptographic codes that many digital tools rely on. Literature also hasn't forgotten mathematics. Shall we combine cryptography and literature?

*\*We have hidden a secret message in the illustration of this article. Can you decipher it?*





## PLAYING AND CODING: GETTING STARTED

Today, cryptography is taught in many undergraduate and graduate university programs. Courses that include this discipline, study theoretical tools that enable information to be transmitted reliably and securely.

Encrypted messages are used in diverse fields such as espionage or commercial transactions. They also present an extraordinary intellectual challenge for anyone who wants to "play" with them. Literature contains wonderful examples of coded messages that structure the plots of certain stories. Here are two examples.

### THE ADVENTURE OF THE DANCING MEN: A CRYPTOGRAM IN A MYSTERY STORY

Sherlock Holmes, the famous detective created by Arthur Conan Doyle (1859–1930), was known for his great deductive skills. He had a "mathematical mind." In his short story *The Adventure of the Dancing Men*, the detective also uses his cryptographic skills.

In this story, Hilton Cubitt seeks Holmes' help to unravel a mystery involving his wife: Elsie is distressed after receiving strange messages. These contain no words, only stick figures with arms and legs positioned in various ways, some carrying flags and, at times, even turned upside down. Holmes explains:

*These hieroglyphics have evidently a meaning. If it is a purely arbitrary one it may be impossible for us to solve it. If, on the other hand, it is systematic, I have no doubt that we shall get to the bottom of it.*

Holmes begins his investigation by studying the frequency of each symbol (each stick figure) in the messages Elsie receives and compares it with the frequency of letter usage in English.

*Having once recognised, however, that the symbols stood for letters, and having applied the rules which guide us in all forms of secret writings, the solution was easy enough.*

The detective starts by identifying the most repeated symbol, which must correspond to the letter E, the most common letter in English texts. Guided by context, grammar, and common sense, Holmes decodes the hidden meaning of the cryptograms.

In fact, this "alphabet" of "dancing men" was an invention of Patrick, Elsie's father and leader of a gang of criminals. This way of writing allowed him to send warnings to his gang. Because they looked like a silly game, these messages went unnoticed by anyone who didn't know the key.

Despite uncovering the code, Holmes fails to prevent the murder of his client, Hilton Cubitt, although he does unmask the killer. Already familiar with the hidden code, he sends a message in the "dancing men" alphabet, pretending it comes from Elsie...

## LITERATURE CONTAINS WONDERFUL EXAMPLES OF CODED MESSAGES THAT STRUCTURE THE PLOTS OF CERTAIN STORIES



## ENCRYPTED MESSAGES ARE USED IN DIVERSE FIELDS SUCH AS ESPIONAGE OR COMMERCIAL TRANSACTIONS

### THE GIANT RAFT: A CRYPTOGRAM IN AN ADVENTURE NOVEL

*The Giant Raft. Eight Hundred Leagues on the Amazon* is an adventure and suspense novel by Jules Verne (1828–1905).

The story takes place in 1852. Joam Garral, a man of Brazilian origin, owns a prosperous estate in Iquitos (Peru). He is the father of Benito and Minha. His daughter is about to marry Benito's best friend, Manuel Valdez, in Belém (Brazil). Garral decides to transport the family entourage and servants aboard a large raft heading for the Atlantic coast of Brazil, down the Amazon River. They must travel eight hundred leagues along the river to celebrate the wedding.

But Garral has a secret: he is a fugitive from Brazilian justice. Years ago, he was falsely accused of theft and murder. He had to flee Brazil to avoid an unjust punishment: a death sentence for a crime he didn't commit. Upon reaching Manaus, Torres, a sinister character, blackmails Garral, demanding that he marry Minha in exchange for his silence. Garral refuses to submit, is arrested, and sentenced to death.

However, Torres possesses a coded document with the confession of the real murderer. This manuscript uses the so-called *Gronsfeld cipher*, which is more complex than the code Conan Doyle uses in *The Adventure of the Dancing Men*. While Doyle's story uses a substitution cipher where each character in the original text is replaced by another in the coded text, the cipher in *The Giant Raft* is polyalphabetic: each symbol does not always correspond to the same character. Moreover, it uses a numerical key to encode and decode. Here's an example. Let's first fix an original 26-letter alphabet:

ABCDEFGHIJKLMNOPQRSTUVWXYZ.





Let's suppose the message we want to send is: **BIZKAIATECH MAGAZINE**. With the key 12345, the encrypted message would be: **CKCOFJCWIHI ODKFAKQI**.

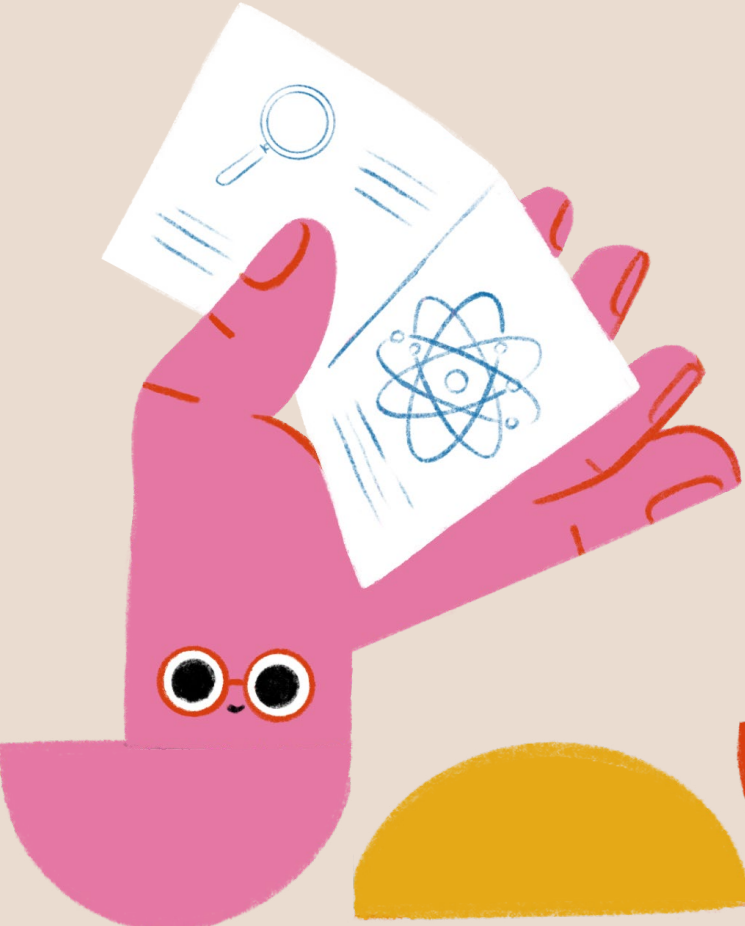
How is this obtained? The key (one digit per letter) is placed under the text to be encrypted and repeated as many times as necessary. The encrypted message is produced by replacing each original letter with the letter located (to the right in the fixed alphabet) by as many positions as indicated by the digit below that letter:

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | I | Z | K | A | I | A | T | E | C | H | M | A | G | A | Z | I | N | E |
| 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 |
| C | K | C | O | F | J | C | W | I | H | I | O | D | K | F | A | K | Q | I |

IT'S ALWAYS MORE FUN TO DO IT MANUALLY, AS LONG AS THE MESSAGE TO BE ENCODED ISN'T TOO LONG...

As you can see in the chart, **B+1=C, I+2=K, Z+3=C and so on**. To decrypt the message, simply reverse the process: in the coded message, each letter is replaced by the one located (to the left in the alphabet) by as many positions as the digit below that letter: **C - 1 = B, K - 2 = I, C - 3 = Z, etc.**

*The Giant Raft* begins with a coded message—the final paragraph of a hundred-line encrypted text



(not included in the novel) hiding the confession of a man named Ortega, the true culprit of the crime for which GarraI was accused.

*Phyjslyddqfdzxgasgzqqehxgkndrxu jugiocytdxvksbxhhuypohdvrymhuhp uydjoxphetozsletnrmvffovdpajxhy ynojyggaymeqynfuqlnmvlyfgsuzmqizt lbqgyugsqeubvnrcredgruzblrmxyuhqh pzdrgrcrohepqxufivvrplphonthvddqfh qsnztzhhhnfepmqkyuuxktogzgkyuumf vijdqdpzjqsykrplxhxqymvklhphotoz vdksppsuvjhd.*

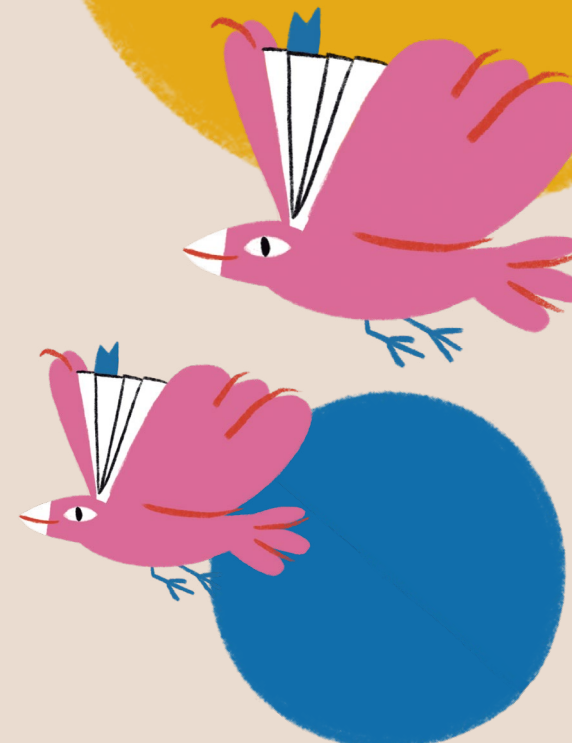
When GarraI is arrested in Manaus, Judge Jarríquez, responsible for his defense, tries to decode the message using various methods. His efforts are unsuccessful. Almost at the last moment, the name "Ortega" is suggested as the possible signatory of the encrypted message. Thanks to this discovery, the judge finds the key and uses the Gronsfeld method (although he does not name it, only describes it) to decipher the hidden message:

*The real author of the robbery of the diamonds and of the murder of the soldiers who escorted the convoy, committed during the night of the twenty- second of January, one thousand eight hundred and twenty-six, was thus not Joam Dacosta, unjustly condemned to death; it was I, the wretched servant of the Administration of the diamond district; yes, I alone, who sign this with my true name, Ortega."*

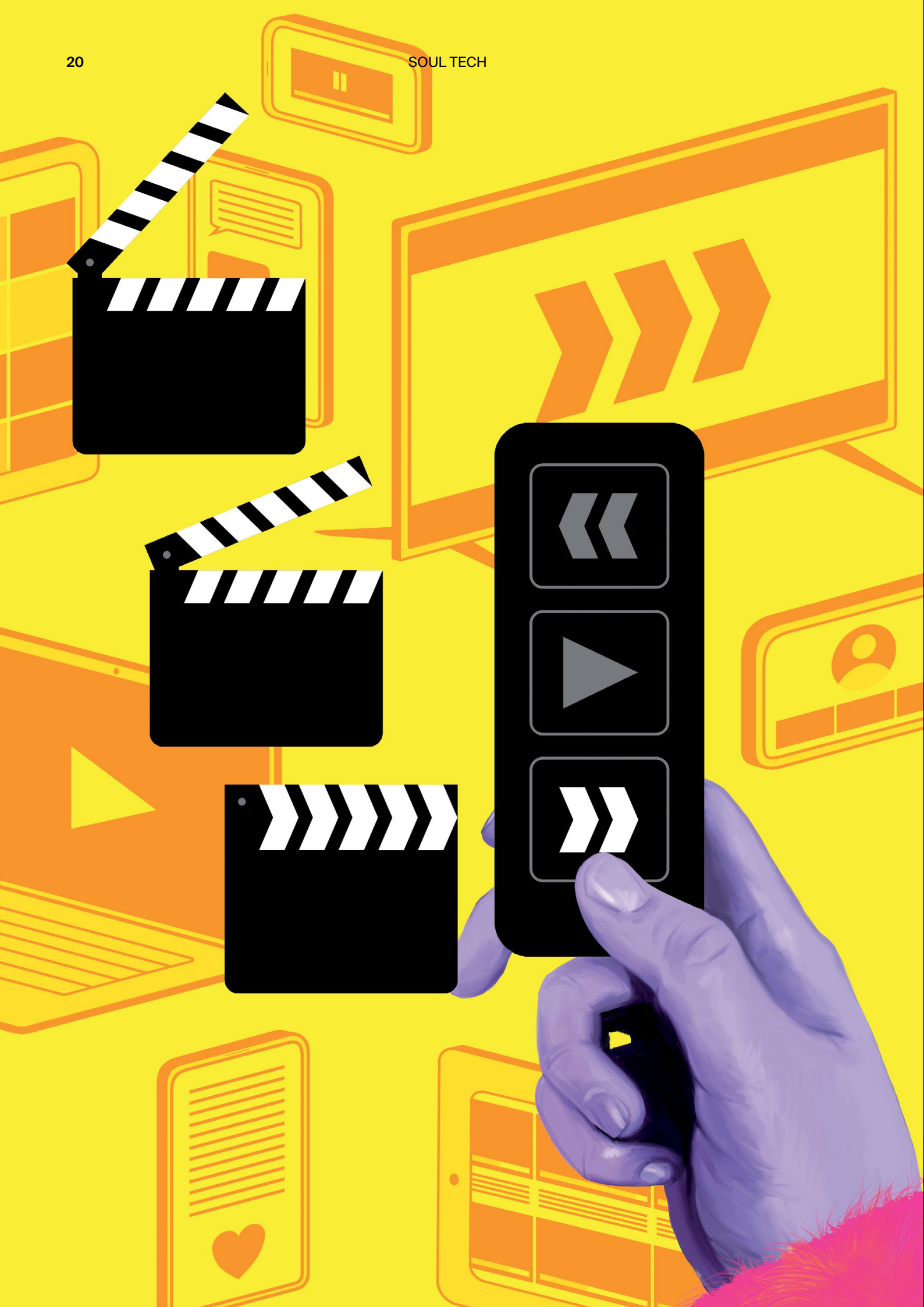
Thanks to this revelation, GarraI (whose real surname was Dacosta) escapes the gallows, and the story ends happily.

USING TECHNOLOGY TO ENCODE AND DECODE

There are many online sites that help encode and decode messages using different encryption systems. My favorite is the website DCode.fr, where I've tested the Gronsfeld method with different alphabets and keys. However, it's always more fun to do it manually, as long as the message to be encoded isn't too long...







# Frieza could you die just a little faster, please?

BY BIZKAIATECH EDITORIAL TEAM /  
ILLUSTRATION JOSEAN MORLESÍN MELLADO

"Will Goku finally kill Frieza today?" That's the question we all ask ourselves every day when we get to class. We've been watching TV at 9 p.m. for nearly two weeks, waiting for this fight to end, but it seems this purple and white "guy" never throws in the towel. In class, a debate erupts every day before the teacher arrives; everyone in the room has their own theory about how it will end: "I think Gohan will kill him!" "Maybe Bulma will invent something to trap him," "maybe they'll gather the Dragon Balls and use them to finish him," "does anyone think Yamcha might be the hero of this story?" Well... no, poor Yamcha has enough to deal with on his own.



One day, things are different. You wake up with a sparkle in your eyes, excited to go to class. Frieza is dead (or so it seems, you never know). What will happen now? How will the story continue? Is there anyone out there stronger than Frieza in this wonderful world?

### A GENERATION LEFT ORPHANED

Anyone from Bizkaia born between the 80s and 90s knows what it's like to grow up with Hartz Txiki, Son Goku, Shin Chan, and Nobita. Watching TV every day, discussing what happened on the screen with your friends, sharing that content with your family, and eagerly awaiting the next episode. Today, however, these habits are a thing of the past. If we grew tired of the Frieza Arc, we could skip episodes, compressing the entire saga into three chapters: the beginning, the moment when Goku turns Super Saiyan, and the end. If we felt nostalgic and wanted to watch the whole thing, we could put the series on 1.5x speed to finish much faster.

Cartoons, or really all the content we consume, has moved largely outside of live TV. Even the content shown on TV has left the screen due to the rise of “on-demand” platforms. Now, you can watch whatever you want whenever you want without waiting for the next episode. Sometimes, the platform will even play the next episode automatically if you wait a few seconds, without you needing to press a button!

How could our way of consuming content change so much in such a short time? And what effect does this have on society?

### THE BINGE-WATCHING CULTURE

Platforms like Netflix, HBO Max, Disney+, Movistar+, Amazon Prime Video, Filmin, and YouTube have completely transformed the way we consume content. According to CNMC, in 2023, 58.1% of households across Spain had access to at least one streaming platform. In the Basque Country, according to Ikusker (2022), Netflix is the most widely used platform, with eight out of ten respondents (83%) reporting access to it, followed by Amazon Prime Video at 53.3%.

Binge-watching culture, however, is not new; it has been around for quite some time. Oxford Dictionaries accepted the term in 2013, defining it as “the practice of watching multiple episodes of a television program in one sitting, typically by means of DVDs or digital streaming”.

WorldMetric (2024) shared some insights on this phenomenon after digging deeply into it. Here are a few findings:

- Each viewer who sits down to watch a series watches an average of 7 consecutive episodes.
- This phenomenon is much more common among

younger people, with 90% of millennials and Gen Zers regularly practicing binge-watching.

- 75% of people prefer watching an entire series at once rather than waiting a week for a new episode.
- The “binge-racer” culture has grown, where people try to finish newly released episodes quickly to say they were the first to watch them.

Netflix popularized this practice, and although it has been successful for the company, it has sparked debate among viewers. Medium says that in the long run, binge-watching does not satisfy viewers. Those who wait a bit longer to watch episodes tend to retain more information and give, on average, a more positive rating. Also, cliffhangers and dramatic moments don't have the same impact when watching the series all at once, which diminishes the enjoyment of the content.

This phenomenon is also closely linked to mental health. Watching series this way can become addictive, as it causes drastic mood swings. It can also lead to insomnia, feelings of isolation, and emptiness after watching something that elicited strong emotions. Who knew that all that glitters isn't gold?

### SON GOKU *EUSKALTZAIN*

Another issue posed by streaming platforms and online content is the limited use and visibility of Basque. While

these platforms may have a few movies or series in Basque, the catalog is very sparse compared to what Euskal Telebista offers. According to the previously mentioned Ikusker (2022) report, 67.7% of content consumed on these platforms is in Spanish, 26.5% in English, and only 0.7% in Basque.

**Now, you  
can watch  
whatever  
you want  
whenever  
you want  
without  
waiting for  
the next  
episode**



For minority languages, audiovisual content consumption is crucial. Idoia Alberdi (EITB Media, 2022) points out, "The new audiovisual consumption models are directly impacting the linguistic habits of young people, and this is leading to setbacks in the use of Basque. By far, most of the content consumed is in Spanish. We need Basque-speaking creators and influencers on social media, in gaming, and on all digital platforms. When quality content is available, it is consumed in Basque. The EITB series *Go!azen* is a prime example. Given this scenario, a firm commitment to Basque-language content in the audiovisual sector is urgently needed, with EITB playing a significant role, alongside RTVE".

The association Tinko Euskara is working hard to change this. Created in 1994, this organization tirelessly strives to get popular titles translated into Basque and shown on the big screen. They also work to bring Basque-language content to schools so that it can be used as educational material, aiming to increase Basque use among young people.

Pr1meran is another platform created to boost Basque-language content and content produced in the Basque Country (although some of it may not be in Basque).

Unlike the platforms mentioned earlier, Pr1meran is free. So if you feel like spending the evening eating popcorn and watching Doraemon, now you know where to go!

### 9 P.M. HERE OR IN IDAHO?

How we discuss the shows we've watched has also changed dramatically in recent years. With such a huge catalog, how can I keep up with what my friends are watching? Also, even if we're watching the same series, we may be at different points in the story...

No problem, that's what social media is for! There's nothing like finishing an episode, opening Twitter (X), and seeing it trending. Memes, theories, thoughts, opinions, Easter eggs you missed... you get it all. Your Instagram and TikTok feeds are also full of content, where you can read others' thoughts and share your own.

In addition to social media, there are apps created specifically for content consumers. TV Time is one; initially launched in 2011 for tracking and discussing series, it now also lets you track movies. It helps you keep track of what episode you're on, so you don't get lost. You can also leave comments on episodes, like others' thoughts, and debate with anyone on the app.

You can even see the total time you've spent watching series and movies...

Letterboxd is essentially the same but specializes in movies and miniseries. Created in 2011, it got popular during the COVID-19 pandemic. As of February 2024, there are 12 million users registered. You can mark movies you've seen, those you want to watch, and those you've liked, and rate each one (up to 5 stars). You can also comment, make lists of any type with movies of your choice, and see what others are watching. They're the masters of marketing too, with many Hollywood stars using their platform. Even the famous director Martin Scorsese has his own account!

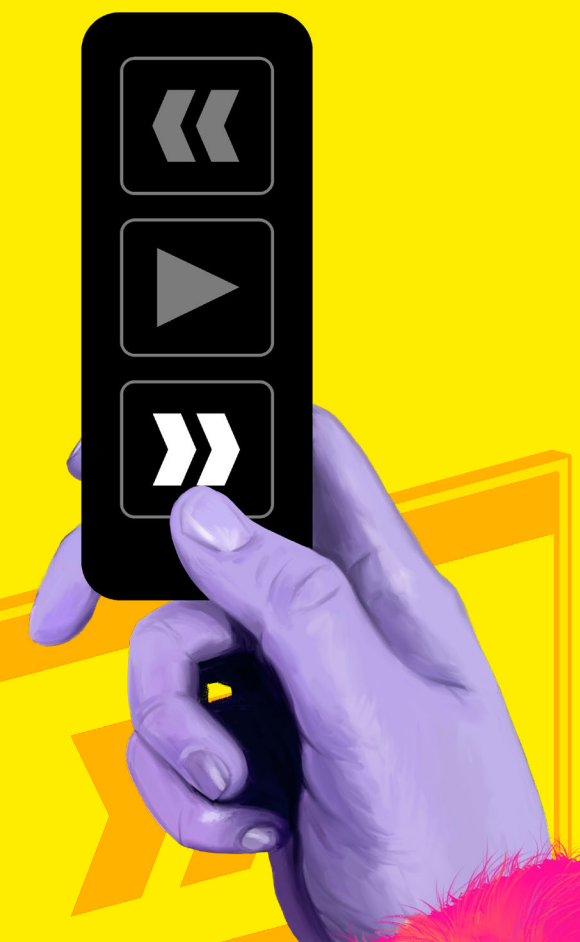
**Isn't that, in essence, the purpose of storytelling?**

### THE NEVERENDING STORY

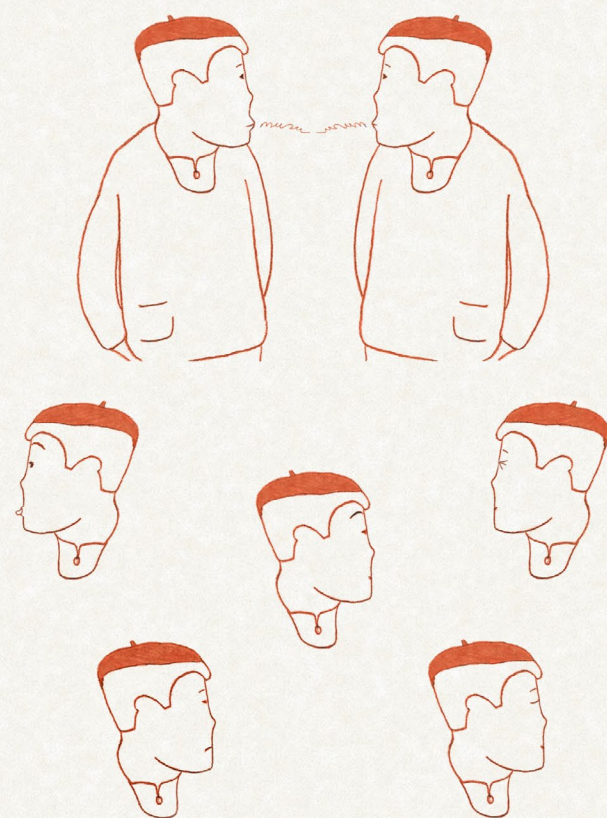
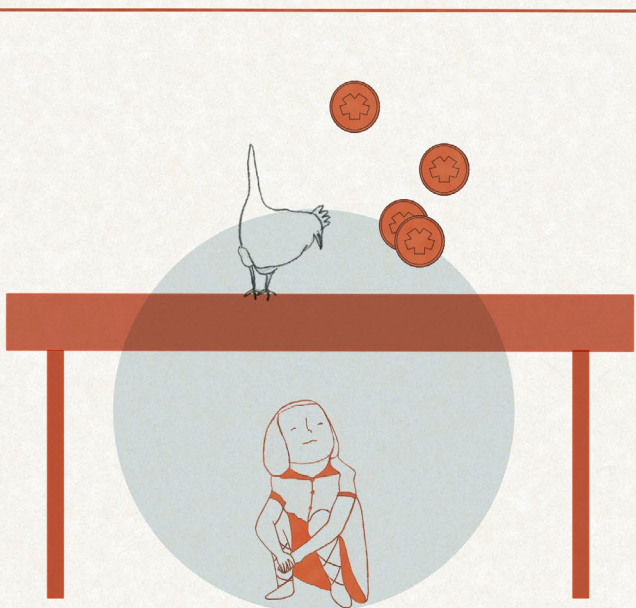
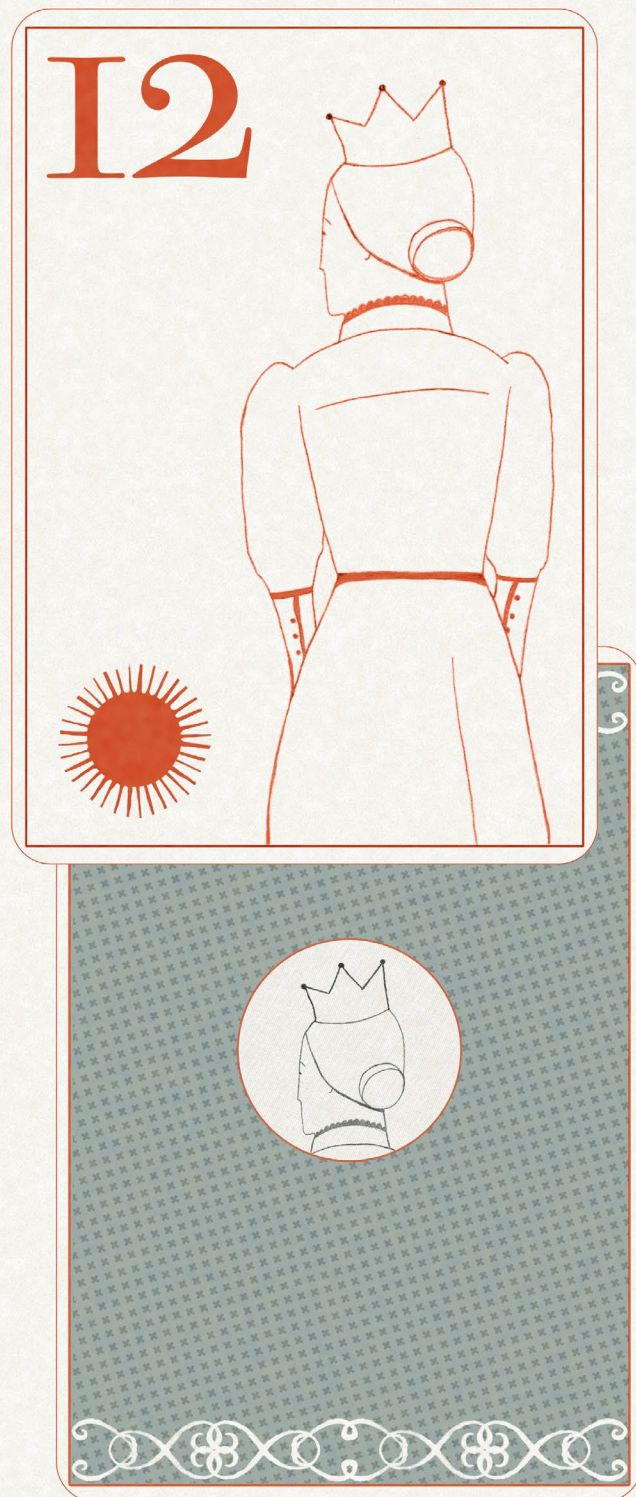
One thing's clear: nothing in life is permanent. Everything we experience changes sooner or later, and how we tell and consume stories is no exception.

In a society where spoilers are the ultimate taboo, wouldn't it be nice if we could recapture the excitement we felt watching Frieza and Goku's battle? That way, in the future, we'd remember what we're watching now with nostalgia and fondness, creating an emotional connection to the content we consume. Isn't that, in essence, the purpose of storytelling?

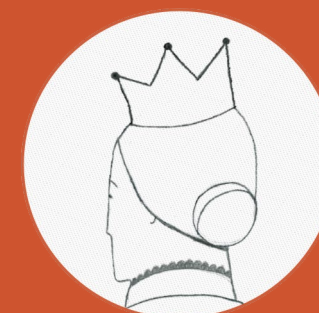
One thing's for sure, though, even if everything else changes, there's one thing that never will: poor Yamcha's luck. Hang in there, buddy; everyone's rooting for you.







# ALL ABOUT 31: HOW TO PLAY MUS



BY BIZKAIATECH EDITORIAL TEAM / ILLUSTRATION LEIRE LLANO

Shall we play Mus? What? You don't know how? Well, we'll have to fix that, won't we?



Later, we'll share an article explaining the probabilities of winning a game of Mus, but first, you need to learn how to play, right? Don't worry; it's not as hard as it seems.\*

\*We'll explain how to play Mus with eight Kings. If you want to play with four, only the card values will change.

### FAMILY GATHERING

To play a game of Mus you need four people, it's always played in pairs. Once you have three other players, it's time to deal the cards. Be careful, though: the person dealing must have the deck cut by the person to their left, to ensure they haven't stacked the deck to keep the Kings (the best cards, remember). After the deck is cut, deal four cards to each player.

Once the cards are dealt, each player looks at their hand. If you have a good hand (we'll explain that shortly), you can start playing. Through gestures, you can discreetly signal your partner that you have a winning hand (but be careful, you could get caught!). If you don't like your cards, you can say mus, indicating you want to redraw. However, for a new draw, everyone at the table must agree to say mus. If even one player wants to start, the game begins, and everyone must play with their current hand.



### WHAT YOU WANT IN HAND

Kings, Kings, and more Kings! That's what you want for a good hand. Here's the card hierarchy: Kings are the highest, but since there are only four in the deck, the four cards marked "3" also count as Kings. After Kings, the next best cards are Knights (*Caballos*), then Jacks (*Sotas*), and so on. Cards valued "2" are worth the same as "1" and they have the lowest value (this equalization ensures there are eight of each).

### WHAT GAME ARE WE PLAYING?

Mus is divided into four mini-games: *grande* (high), *pequeña* (low), *pares* (pairs), and *juego* (game), always in that order. Let's start with grande:

The player to the dealers right begins. When someone "cuts" the game, we start playing grande. Here, the goal is to have the highest-ranking cards, especially Kings. One King beats four Knights or any hand without Kings, as cards are valued individually, not as sets. The best hand for this game is four Kings, followed by three Kings and a Knight, three Kings and a Jack, and so on. Got it?

After *grande*, we move on to *pequeña*, the opposite game. Here, the goal is to have the lowest cards, with the best hand being four ones. After that, it's three ones and a four (remember, twos count as ones, and threes as Kings), three ones and a five, and so on.

In these first two games, all four players participate. But for the next two, things change. The third game, *pares*, is for players holding matching cards. If you don't have pairs, you're out; simple as that. There are three types of pairs: you can have one pair (two matching cards), which is the weakest pair, you can have *medias* (three matching cards, which are quite good and then there's the *duples* (two pairs of matching cards), which is the best hand for this round. The player with the strongest pairs wins. For example, two Kings are beaten by a *media* of fours (three cards of 4), even though fours are lower in value.

Finally, we reach *juego* (game). Like the previous round, only players holding a "game" can participate. But what qualifies as a game? Here, you sum the values of your cards. All face cards (and threes, which are Kings) are worth 10 points. Cards from 4 to 7 retain their face value, and ones and twos are worth 1 point. The goal is to have 31 points. Examples include: three Kings and a one; Jack, Knight, King, and a one; or two Jacks, a seven, and a four. If no one has 31, the best game is 32, followed by 40, then

## GO TO THE KITCHEN AND GRAB A HANDFUL OF CHICKPEAS, WE'LL EXPLAIN IT QUICKLY

descending to the worst game, 33. If no one has a game, the round is decided by *punto*, where the goal is to get as close to 30 as possible.

### KEEPING SCORE

Now we technically know how to start our first game of this fun game, but what's the goal? How do we know if we win or lose? How do we keep score? Go to the kitchen and grab a handful of chickpeas, we'll explain it quickly.

A game of Mus is usually played to 40 points (*tantos*). But don't worry, you won't need 80 chickpeas to keep track of everything. When you "lift" a point, it's collected by one of the two players in the team. Once that person has 5 points, they return them to the center of the table, and the other player gets an *amarraco*, which is worth five points. Upon reaching 35 points (seven *amarracos*), all the points are put back in the center, as a way to warn the other team that you're just 5 points away from winning the game.

But, when should you lift a point? Mus is a betting game where you wager on your and your partner's cards to win. You can bet because you've got a good hand or just to confuse your opponents. You can bet whatever you want: an *envido*, which is worth two points (you never bet just one point, and we'll explain why later), three, four, or even the entire game, 40 points, which is called an *ordago*.

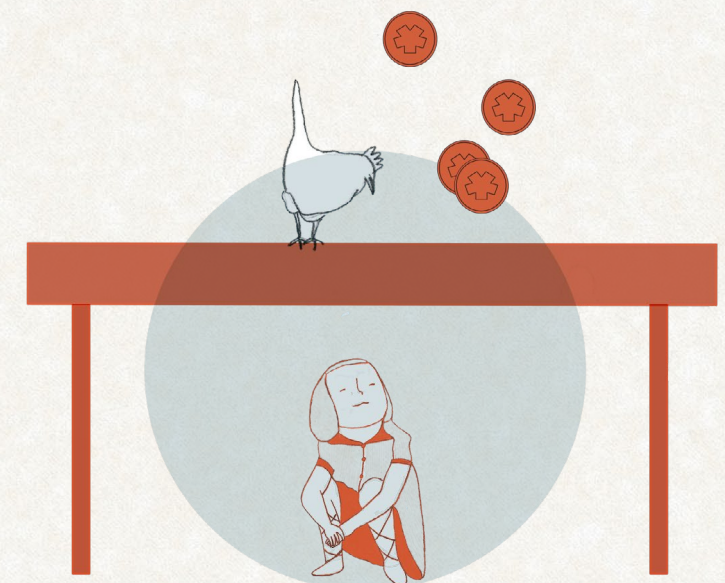
If we're starting the game and someone bets on the grande, we have three options. The first would be to decline; do we have a hand without any Kings? Well, in that case we won't want to participate, so we pass, so the person who placed the *envido* would lift one point since they made the bet and no one followed. The second

would be to accept the bet; we have a pair of Kings, so it's worth it, we're in. Those two *tantos* we played will be counted at the end, once everyone reveals their cards. Lastly, there's the option to add more *tantos* to the bet; we have three Kings and a Knight—it's in the bag. Since we have an amazing hand, we'll raise the bet by five more *tantos*. If the person who placed the *envido* is confident they can win, they'll accept, and these points (seven total) will be counted at the end of the round. However, if they're not convinced and say they won't accept, our team will take the initial bet, which in this case was two *tantos*.

If it's our turn to start the game, but we don't have a good hand to bet anything, we can pass and let the others begin. If everyone passes, when the cards are revealed at the end, we'll see who won the round, and they'll take one point.

### PRACTICE MAKES PERFECT

Yes, it's true that all of this sounds quite complicated to understand and get started, but once you get the hang of it, we know it'll become your favorite way to spend time with your friends or family. Otherwise, you always have the option of playing Mus apps on your phone... you've got to start somewhere!





# A CALCULATED ORDAGO

BY NAIARA ARRIZABALAGA AND LETICIA HERNANDO (UPV/EHU) /  
ILLUSTRATION AINARA AZPIAZU



Have you ever heard someone say there's math in everything around us? I'm sure you have, but is that true? Where can we actually find it?

In this era of rapid technological advancements, social media, algorithms, and artificial intelligence, everything moves at breakneck speed. Let's take a breather. Let's set aside our phones and recall our traditions: *euskal dantzak*, *bertsolaritza*, *esku-pilota*... We'll take ourselves back to one of those slow summer afternoons, where, after a meal with friends, you play a game of mus. Time slows down.





Mus, briska or julepe are card games that are part of our culture, embedded in our lives for centuries. And yes, even here we can find math.

#### CHANCE AND PROBABILITY

Like any good game, a player's skill is essential to win. But in card games, luck also plays a role. And here's where things get interesting, as you're left to play the hand you're dealt.

Chance constantly disrupts our lives, and from experience, we can get a sense of the probability that certain random events will happen. Probability is the mathematical calculation that evaluates the likelihood of an event occurring when chance is involved. Often, we hear that there's a percentage chance of something happening. For instance, there's said to be a 50% chance of flipping a coin and getting heads. However, in math, probability is measured with values between 0 and 1. If there's no chance the event will happen, the probability is 0. On the other hand, if the probability is 1, we know it will happen for sure. So, mathematically, the probability of getting heads in a coin toss would be  $\frac{1}{2}$ . For example, if we calculate the probability of rolling an even number on a die, the result is  $\frac{3}{6} = \frac{1}{2}$ , as there are three possible even numbers (2, 4, and 6) out of a total of six possibilities. This is known as: probability equals the number of favorable outcomes divided by the total possible outcomes. So, could we analyze the probability of having a "good hand" in mus? Let's take a look.

#### THE RULES OF MUS

In mus there are four players and each receives four cards. According to the Fournier rulebook (if playing with 8 kings), the objective of the "game" is to equal or exceed 31 points by adding up the value of each card. The best game is 31 points, followed by 32, then 40, descending to 39, 38, 37... all the way to 33, which is the worst game. If no one reaches 31 points, then the game is decided by the "point," meaning the winner is whoever gets closest to 30 points.

As for card values, each card from ace to seven scores its face value, except for the twos, which are worth one point (the same as an ace), and threes, which are worth ten points, just like the king, jack, and queen.

## We'll take ourselves back to one of those slow summer afternoons, where, after a meal with friends, you play a game of mus



The points are tracked with the help of amarracos, and mus is typically played in pairs. Betting money or not depends on the context and each player's confidence in their skills!

#### PROBABILITY IN MUS

A "good hand" is, for example, receiving three cards each worth 10 points, as the fourth card then guarantees that you'll have a playable hand. Moreover, if the fourth card is worth 1, you'll have 31 points, the best game. So, what's the probability of getting three cards worth 10 plus one card worth 1? To find out, we calculate the number of favorable outcomes—how many ways there are to get those four cards—and the total number of possible ways to deal four cards from a 40-card deck. For the favorable outcomes, let's calculate how many ways we can get three cards with a value of 10 points

# 12

plus one card that is either an ace or a two. We'll focus on kings and king equivalents (threes): out of a total of eight kings and threes, we want to get three. There's a mathematical tool for calculating combinations, where 8 elements are taken 3 at a time, expressed as the binomial coefficient  $\binom{8}{3} = 56$ . We also want the fourth card to be an ace or a two, which gives us eight options, so we multiply those 56 combinations by 8, giving us a total of 448 ways to get the desired four cards. That sounds like a lot, doesn't it? But we shouldn't be fooled, as we don't yet know if that's a lot or a little without knowing the total number of ways to deal four cards.

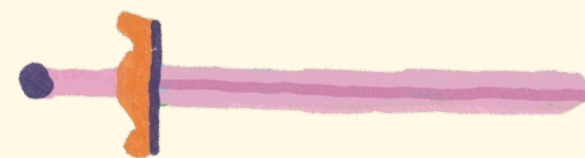
To calculate the total number of ways we can receive four cards from a deck of 40, we again use the combination formula:  $\binom{40}{4} = 91.390$ .

Now we calculate the probability of getting these specific cards with the formula: number of favorable outcomes divided by total possible outcomes:  $448/91.390 = 0.0049$ . So the probability is 0.0049, or about a 0.5% chance of getting three tens and a one... not so high, is it? But don't worry, there are other ways to reach 31 points, and you don't need 31 points to win a mus game!

In fact, now that we know how to calculate probabilities, we could calculate the probability of getting any other "good hand." For example, getting 40 points. Want to try calculating it?

#### THE ENDLESS POSSIBILITIES OF MATHEMATICS

We've seen that mus combines strategy and luck. But understanding the probabilities of certain card combinations allows us to make more informed decisions, which can tip the balance in our favor.

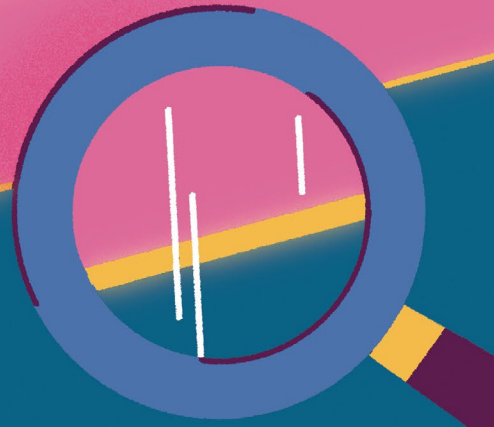


Math enables us to go further in probability calculations, accounting for other possibilities. We know that winning at mus doesn't depend solely on our hand but also on what the other players have. We might love to predict our opponents' cards, but that remains uncertain. What we can calculate is the probability of winning a game based on the cards we hold. These probabilities are known as conditional probabilities and follow the most important theorem in probability theory: Bayes' theorem. Though introduced over 200 years ago, this theorem is the foundation of advanced artificial intelligence techniques, such as the algorithms behind the famous ChatGPT that recently appeared in our lives.

So, the next time you sit down to play mus, remember that behind every move and decision, there's a world of probabilities you can use to your advantage. Good luck!







# SCIENCE ALSO HAS ITS SQUARE

BY UXUNE MARTINEZ (BZP) / ILLUSTRATION DANI MAIZ

A square is a wide, open public space nestled within cities and towns. It is the stage for public life, a meeting place and a pathway for the comings and goings of those who live in a town. A square is a refuge for experiences, events, celebrations and performances; it is the cradle of culture. A square is a space, a place, a station, and now, science also has its own square:

Bilbo Zientzia Plaza.



What is Bilbo Zientzia Plaza? Bilbo Zientzia Plaza (BZP) is a project of the Chair of Scientific Culture at UPV/EHU and is the state's most important scientific outreach festival. It offers a program filled with various types, tones, and initiatives to engage both adults and youth with science. Over three weeks, a series of free, interconnected events are offered. These include street exhibitions (*Zientzia Kalean*), guided tours, humorous science monologues (Ciencia Show), conferences (Naukas PRO and Naukas Bilbao), live experiments, documentary forums, shows, children's workshops (Naukas Kids), or educational sessions combining *bertsos* (a traditional Basque form of poetry) with science (*Bertsozientzia*), or others that mix art, science, or dance with science.

## WE ACQUIRE A SIGNIFICANT PART OF OUR SCIENTIFIC KNOWLEDGE OUTSIDE FORMAL ACADEMIA

Scientific outreach activities are common in our society. Many such initiatives are organized during the school year, often by universities, research centers, associations, foundations, or public institutions. Among these are events tied to specific calendar dates: Science Week, the International Day of Women and Girls in Science, the European Researchers' Night, or International Pi Day. These events feature numerous activities to share the intricacies of science and the work of those who pursue scientific careers. These are called "supplementary activities," meaning they fall outside regular cultural programming and align with specific events or initiatives, often organized as university activities during the school year.

Bilbo Zientzia Plaza was born to break from

the norm. It aims to step outside predefined contexts, worlds or dates to show that science can be part of cultural life and enjoyed year-round.

### THE SPORES OF SCIENCE IN A CULTURAL LANDSCAPE

But BZP has other purposes as well. Incorporating scientific outreach into cultural programming affects how knowledge is shared. Presenting scientific topics in formats we consume during our leisure time is like spreading the spores of a plant: new seeds are dispersed into unconventional environments. Studies have shown that we acquire a significant part of our scientific knowledge outside formal academia: visiting museums, going on guided tours, attending talks, participating in workshops, or consuming scientific content.

Scientific communication experts like Vladimir de Semir, a journalist and director of the Scientific Communication Observatory at Pompeu Fabra University, echo this idea. They stress the importance of these activities: "Contrary to popular belief, people learn science outside of formal environments: less than 5% of a person's life is spent in formal education. Therefore, the key to increasing public understanding of science lies in the remaining 95% of our lives."

Based on this, the key to influencing scientific literacy is recognizing both the time and space we spend outside academia and organizing outreach programs that fit into leisure activities. Thus, why not make space for science within cultural programs? Bilbo Bizkaia Plaza is held each year to address this question, offering a festival that invites people to enjoy and expand their scientific knowledge.

### LEARNING BY ENJOYING

Leisure brings us into a unique setting, away from our daily tasks, where we merge free time with enjoyable or entertaining activities to rest. Watching a movie, attending a *bertso* session, joining a roundtable,

visiting an exhibition, listening to a recital, taking part in a book club or attending a conference series are activities we find useful, beneficial, or pleasant and, in any case, enjoyable.

At Bilbo Zientzia Plaza, we enjoy two consecutive days filled with fascinating stories presented by more than 70 science and outreach professionals from European, national, and local research centers. These stories include, for example, that lucid dreams can be controlled, that the history of life can be told through art, that certain clouds can cause fires, that humans begin understanding words before birth, that plants can move from one place to another, or that there are astronomical objects in space that become younger over time.

## BILBO ZIENTZIA PLAZA WAS BORN TO BREAK FROM THE NORM

We enjoy, for example, a science cartoon exhibition by Forges. We marvel as a physicist explains their tools during a guided tour. We delight in learning biology by observing animal tracks in Bilbao parks. We laugh at a science monologue at the Bidebarrieta Library. We're amazed with our children when we see science and circus come together in a juggling show at the Abandoibarra esplanade.

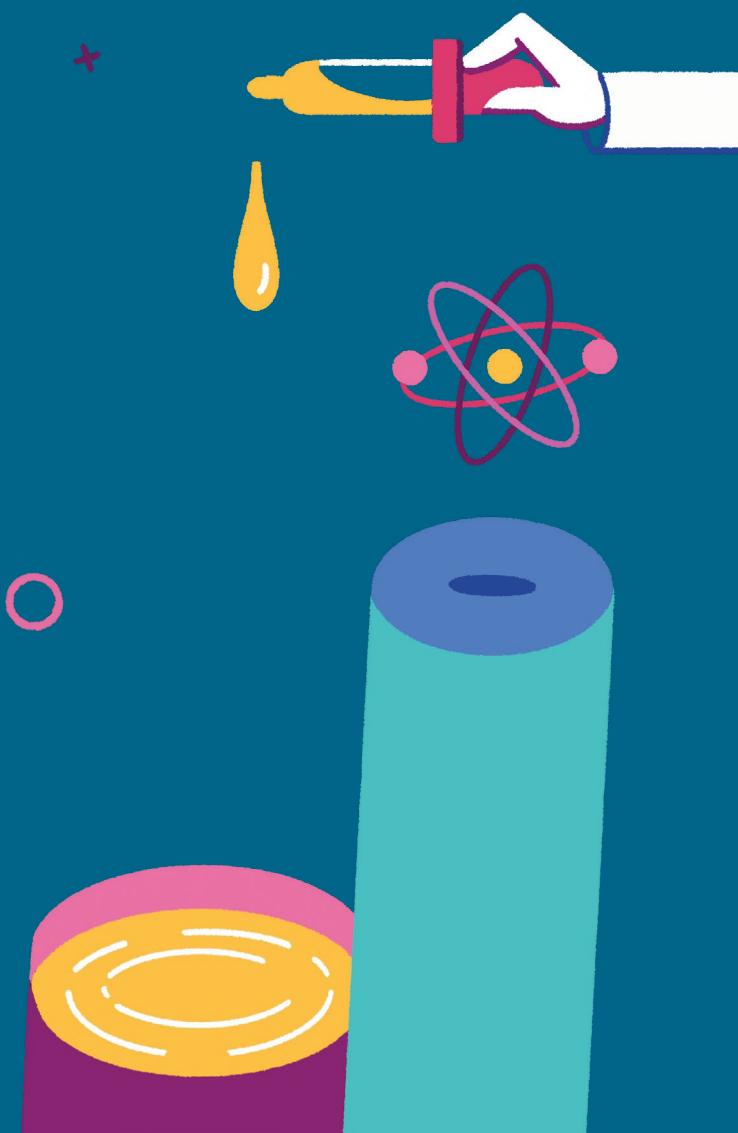
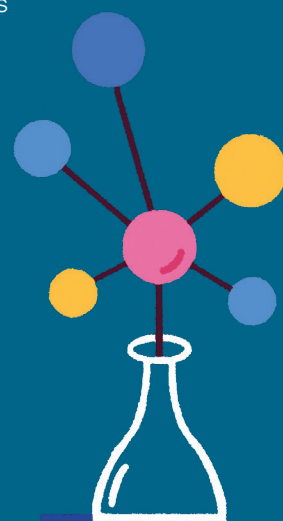
We recognize that BZP does not appeal to everyone. Yet, there will be those who attend an event and find enjoyment, others who are moved, and still others who return home with a curiosity to learn more. Regardless, anyone who attends a BZP event will leave with something new: a fact, a story, an event, or something unknown before that enhances their scientific literacy.

Each year, BZP gathers over 6,000 people in various venues. Thanks to live broadcasts by EITB, thousands more (39,000 in 2023) watch, for example, the talks

given at the Euskalduna Bilbao Auditorium. However, these outcomes would be impossible without the proactive attitude of the public, keen to expand their understanding of science.

Bilbo Zientzia Plaza (BZP) was born in 2017 through the efforts of the Chair of Scientific Culture at UPV/EHU and the Government of Biscay. The BZP project began as Bizkaia Zientzia Plaza, but soon relocated to Bilbao, consolidating as Bilbo Zientzia Plaza with support from the city council. From September 10 to 30, 2024, BZP celebrated its seventh edition. For three weeks, the science-filled stages across Bilbao became the setting for a special protagonist: science, showcased across a wide range of topics.

After eight years, Bilbo Zientzia Plaza has proven that scientific outreach has a place in cultural programming, that scientific topics belong in public spaces, and that by enjoying science, we can expand our knowledge. Indeed, science has its own square.





# SCIENCE OR FICTION?

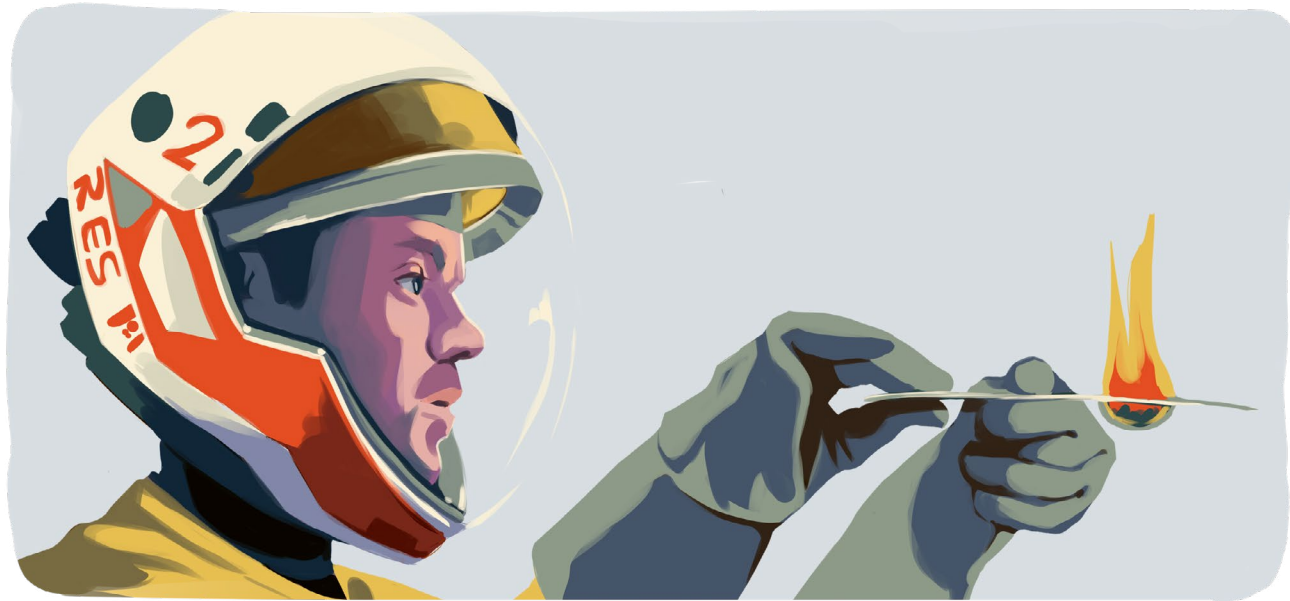


BY BIZKAIATECH EDITORIAL TEAM / ILLUSTRATION NAIZU MAULEON

There's no doubt that disconnecting from the world by watching a movie or series is one of life's greatest pleasures. But you have to be in the mood. If you're going to see a romantic comedy, you know you're going to laugh and cry in equal measure. If you're watching a horror movie, you know you'll probably jump a few times. If it's a drama, the theater will be full of teary eyes as soon as the lights come on. But if you're watching a sci-fi movie, you never know what to expect. That's because sometimes, while you enjoy the "fiction" part, the "science" part might seem convoluted, far-fetched, or make you feel like you're back in your high school physics class.







But one thing doesn't cancel out the other. Some movies, even if they are over-the-top (and let's face it, who doesn't love that?) and purely fictional, stick to scientific principles. What they say makes sense, basically. Others, however, don't come close to accurately representing what they're trying to depict, leaving the scientists and experts in the audience shaking their heads. That's why we're going to talk about three movies that sparked a lot of discussion in the world of science. How much truth do they really hold?

**Warning:** This article contains some major spoilers. If you haven't seen these movies and don't want to know what happens, go watch them and come back afterward. We're sure you'll love them!

#### **The Martian (2015)** **Dir. Ridley Scott**

Ridley Scott loves a good sci-fi movie. And that's exactly what he delivered in 2015 with *The Martian*, a great science fiction film. It tells the story of a NASA astronaut named Mark Watney (Matt Damon) who travels to Mars with his crew for an exploration mission. He's presumed dead after a sandstorm forces the crew to abort the mission and leave without him. As a result, Mark finds himself stranded on the planet with supplies for 300 sols (1 sol is a Martian day, roughly equivalent to 24 hours and 40 minutes, or about 309 Earth days), completely alone.

Luckily, Mark isn't just an average person who'd succumb to an existential crisis within three days. He's a trained astronaut, engineer, and botanist who manages to survive (with some serious setbacks) long enough to reach the Schiaparelli crater, where the arrival of the Ares IV mission

will save his life. But here's the million-dollar question: how does he survive in such conditions? Could this actually happen in real life, or is it completely far-fetched?

The movie's story is based on a book of the same name by Andy Weir, a science fiction writer and software engineer who described himself to Forbes as a "space nerd." With that in mind, it's fair to say his fascination with space drove him to write a scientifically grounded, informed, and logical book; with a few liberties, of course. Ridley Scott's big-screen adaptation does it justice, and here's why.

Let's start with how Watney gets food: yes, the famous potatoes sent to Mars for the crew's Thanksgiving dinner. Good thing he's a botanist! Using the preserved feces of the crew, he creates fertilizer to grow those 12 potatoes and produce more. This process seems plausible at first glance. NASA has even conducted simulations of growing food on Mars, with great success. Maybe they're hinting at something?

After all this, our favorite botanist realizes that even with plenty of potatoes, he'll need water to grow them. Smart thinking. Watney knows the recipe, too. Specifically, he mentions that each cubic meter of soil needs 40 liters of water, so he gets to work. First, he takes the hydrazine (rocket fuel) left over from the ship and passes it through an iridium catalyst (handy things astronauts have!) to separate it into nitrogen and hydrogen. Then, he isolates the hydrogen, releases it in a small, sealed area, combines it with oxygen, and burns it to produce water. The experiment backfires (literally) and he gets smacked around pretty hard. But what matters is that this method

is scientifically sound. Extracting water this way is indeed possible, albeit extremely risky. Watney even jokes in the movie: "NASA doesn't like fire because fire makes everyone die in space." Wise words! However, let's not kid ourselves... getting hydrazine wouldn't be that easy for the average person.

But not everything is accurate in this movie... Remember the storm that left Watney stranded? In both the book and the movie, it's depicted as a raging, violent storm, but such a scenario is unlikely on Mars. Dust storms are indeed common on the red planet (sometimes they're so massive they can be seen from Earth with a telescope!), but NASA points out that the depiction of the wind isn't entirely accurate. Due to Mars' thin atmosphere, much stronger winds would be required to knock over an entire crew and their equipment. Andy Weir knew this, but he decided to leave it as-is in his story. Fair enough, Andy, we love this kind of drama!

#### **Tenet (2020)** **Dir. Christopher Nolan**

If you walked out of *Tenet* (2020) feeling like you understood every detail, congratulations, you probably have an IQ well above average. Christopher Nolan's two-and-a-half-hour science rollercoaster certainly leaves no one indifferent. This intense film follows "The Protagonist" (John David Washington), who finds himself caught in a web of international espionage involving futuristic technology designed to prevent the outbreak of World War III. Along the way, he encounters Neil (Robert Pattinson), who seems to know more about what's happening than The Protagonist himself. Intrigued? Let's dive in.



The film delves into several scientific conundrums, but the most intriguing is its focus on entropy, which ties into the second law of thermodynamics. There are four laws of thermodynamics (originally three—1, 2, and 3—but later a "zeroth" law was added as a foundational principle), and they're all crucial for understanding how energy behaves, flows, and transforms. Understanding energy behavior also helps us grasp the workings of the universe—a mystery humanity continues to unravel.

The second law, entropy, is our star here. In essence, every system tends toward disorder or chaos over time. What does that mean? It means that energy naturally disperses, increasing entropy as it spreads. National Geographic (2024) illustrates this with a relatable example: "Imagine a cup of hot coffee placed in a room with a cooler temperature. Initially, the heat is concentrated in the cup, but over time, it disperses into the room. This is an example of increasing entropy caused by the chaotic distribution of thermal energy."

This phenomenon is closely tied to the irreversibility of systems, which asserts that you can't perfectly reverse a process without altering its outcome. For instance, you can't un-break your family's favorite vase as if pressing "Ctrl + Z." Unfortunately, no system in real life is perfectly reversible.

But, what if entropy could be reversed? That is precisely what Christopher Nolan tries to convey in *Tenet*, in a completely and utterly fictional way, it should be noted.

In one of the scenes early on in the movie, we see a series of events leading the protagonist to an organization called Tenet, where he meets Laura



(Clémence Poésy), a scientist who works with technology from the future. It's her job to explain to the protagonist how all this technology works, and that's when we see the first fantastic artifact of the entire film: a wall full of bullet holes. You read that right, just a simple wall with bullet holes. Laura gives the protagonist a gun and tells him to shoot it at the wall. The protagonist, however, is confused, as he sees that the gun is not loaded. Nevertheless, he points it at the wall and fires. Everyone knows what would happen if *Tenet* were just any other movie: the gun, being unloaded, would do absolutely nothing. In this scene, however, when he fires, the protagonist is confused; he finds that the gun has done something strange. There's one less hole in the wall, and the gun's magazine now contains a bullet, even though it was empty before the shot.

That's when Laura explains to the protagonist (and the audience) that this technology is based on entropy and that, in the future, someone has managed to reverse it. She shows him two bullets: one is the bullet he just fired, and the other is a completely normal bullet. She explains that one of them is like the two of them, it travels forward in time. The other, however, has reversed entropy, meaning that, to our eyes, its motion is reversed. If we go back to the earlier example, it would be like returning your family's vase to its original state by reversing its entropy, but in a much more violent context.

To better understand this, imagine a box filled with particles. If those particles are stationary and contained within the box, the entropy is equal to 0. However, if the box were to break, all the particles would scatter, dispersing their energy and making the entropy greater than 0, positive, in other words. Entropy is greater than

zero in everything we know in real life; it always tends to increase, and that's why space is constantly expanding. Fiction, however, takes us down a different path. If entropy were negative (less than zero, as it is in *Tenet*) that box that had already been destroyed would go back in time, and the particles would return to being inside it.

And in this incredibly complex way, *Tenet* (the movie, not the organization) manages to explain the second law of thermodynamics in a very entertaining way. After the gun scene, many more follow, featuring stunning visuals and mind-blowing technology that are worth seeing. But for that, you'll need to stop reading and hit play.

**Ant-Man and The Wasp 3: Quantumania (2023)**  
**Dir. Peyton Reed**

Oh, what has our favorite superhero gotten himself into this time? Since this is the third film in the Ant-Man trilogy (so far), let's recap from the beginning to set the stage for this movie. In the first film, Scott Lang (Paul Rudd) is blown away when Dr. Pym (Michael Douglas) gives him a suit that makes him ultra-small, allowing him to visit the quantum realm for the first time, accidentally, of course. This one's a must-watch. The second film, however, is a bit trickier, as this time, they enter the quantum realm on purpose to rescue Janet, Dr. Pym's wife (Michelle Pfeiffer) and Hope Van Dyne's (Evangeline Lily) mother, who got stuck there permanently after becoming subatomic. Don't worry; they manage to rescue her. But then comes the big thing everyone knows about: Thanos and that snap. And what does that have to do with our dear Ant-Man? Well, while conducting experiments, Scott had entered the quantum realm, and the snap happened right while he was inside. He wasn't affected, but unfortunately, he



three people who could pull him out of the nano-world were part of the 50% of the universe's population that vanished. Total bummer.

Which brings us to the third film, set after *Avengers: Endgame*, where Scott Lang has returned from the subatomic world with a lot to share with his family and scientific team. This time, Janet is back with her family, and Scott's daughter, Cassie (Kathryn Newton), has developed an obsession with the quantum realm. She builds a gadget to observe the quantum realm without actually entering it, but things don't go as planned. The device ends up trapping the whole family inside the tiny world.

Even though the movie is literally titled *Quantumania*, the truth is, quantum physics doesn't exactly shine in it. Still, there are two key points worth focusing on to compare the movie to real-world science. The first is the quantum realm itself. Big words. It's where the entire movie takes place, with Kang the Conqueror (Jonathan Majors), the villain of this story, ruling over an entire world of microscopic beings at his mercy. Yep, you read that right: it's a subatomic world inhabited by subatomic creatures, living in an intelligent civilization with surreal landscapes. It's led by a villain exiled there because of his misdeeds against humanity and its universes. But let's get to the point. Dr. Michael Kolodrubetz from the University of Texas makes it clear: "The quantum realm isn't real." As he explains, quantum physics focuses on subatomic particles. Since the building blocks of any matter on Earth are these same particles, we're already living in a quantum world. However, because of its size, humans are far too large to follow the rules of quantum physics and instead abide by the laws of classical physics. Moreover, if such a "realm" existed, we'd never be able to enter it. As Medium points out, we'd need to shrink to a size smaller than a subatomic particle, such as a proton, which has a diameter of approximately  $1,7 \cdot 10^{-15}$  meters, about 10 million times smaller than the smallest virus we know. So, unless someone can create real-life Pym Particles, this part of the movie lands squarely in the category of pure fiction.

The second point worth mentioning is the scene where Scott enters a "probability storm" to retrieve an item that Kang needs to escape the quantum realm and release Cassie, who he's holding hostage. Inside the storm, Scott starts multiplying, creating a place filled with billions of versions of himself. Understandably, the protagonist is completely overwhelmed. The dialogue in this scene unfolds as follows (there's a lot of back-and-forth between the different Scotts, so we've trimmed it to focus on the explanation):

**SCOTT LANG**

Why am I seeing another me?

**M.O.D.O.K.**

You're seeing the possibility of another you. You're in a probability storm.

**SCOTT LANG**

What does that mean?

**M.O.D.O.K.**

All the decisions you could make exist at once. You're inside Schrödinger's box, and you're the cat.



This scene represents quantum superposition, where in quantum mechanics, particles can exist in multiple states simultaneously until observed, at which point they collapse into a single state. In the case of Schrödinger's cat, the cat inside the box is both alive and dead until it's observed. It can exist in both states because we lack the capacity to see inside the box without opening it. But once the box is opened, and the cat is observed, it collapses into one deterministic state: either alive or dead. The movie provides a visual metaphor for this phenomenon, showing the protagonist and all his chaotic variations aligning under a single objective to work together and "collapse" into a single state, Scott as the one and only Scott in the situation. It's a bit convoluted, but the visual metaphor is stunning to watch.

Let's hope Scott Lang stops getting himself into so much trouble. Even a superhero of his caliber probably appreciates a little peace and quiet.



# IN JON CORTÁZAR AND RELEVO'S WORLDS

BY BIZKAIATECH EDITORIAL TEAM / ILLUSTRATION MAI EGURZA

Jon Cortázar has been making video games since he was 12 years old. And he says it like it's nothing. Back then, there were no courses, degrees, or YouTube tutorials to teach you how to make video games, so he decided to learn on his own. He also mentions this with ease. Unsurprisingly, he and his partner Aitor Zumelzu founded Relevo, "a classic Bilbao studio". They opened their doors in 2009 and have been creating, collaborating, and entertaining people for "a good" 15 years. We've talked about a lot of things related to the fascinating and entertaining world of video games, but, as always, we wanted to start at the beginning.





Jon first worked in advertising, but he always kept a place in his heart for his biggest passion, earning the attention of local and national media for his work. He tells us that when the economic crisis hit in 2008-2009, the advertising agency he was part of had to find something to make them stand out, as advertising and communication were among the hardest-hit sectors. They tried different things, but nothing worked. However, he had something up his sleeve... "Well, I have this video game thing that's getting some attention..." And so... that's how this thrilling adventure began.

#### ALIENS, CARS AND SHOTS

*Kar Snatchers* (2011) was one of the first products they brought to market. At the time, they were working with clients, so they created this mobile game for an Opel dealership in Barakaldo, where a UFO had to abduct cars, dodging mines and cows in the process. They also made a game for a metal and hard rock bar called Azzurro (in Bilbao), a quirky game indeed: "The bar has a very '80s vibe, so we made a game for Spectrum, a British computer from that same decade, for its clientele who fit that vibe. The game featured the bar's own bartender, the owner, serving shots. People who were regulars at the bar even appeared on the sidelines. Our goal was to build loyalty among their customers; it was really cool". Could there be a better way to build loyalty than by including customers in a video game set in their bar?

Their first commercial game helped the Opel dealership win a national internal award, and the second turned Azzurro into a cult spot for people who enjoyed retro gaming. Riding this wave of success, they created, developed, and launched *Baboon!* (2015), a game for PS4 and PSVITA (not bad) that became a hit. That's when they decided to continue with the Relevo brand but now separate from the ad agency, giving life to what is now Relevo Videogames SL.

#### AND SO... DO YOU PLAY?

Everyone knows a good team is one of the keys to success in any venture, and the world of video games is no exception. But what does it really take to be part of one of these teams? Jon is clear about it: a team of that caliber needs people who "know about games, who understand games, and who play games".

"I value someone eager to learn more than a super star who thinks they've already learned it all. I've been making games for a long time, and I'm still learning. If you think you already know it all... then you know more than I do."

## A CLASSIC STUDIO FROM BILBAO

Education, resume, and experience are important, of course. Everyone who works in any field must be clear about their role, but beyond that, Jon tells us what he looks for when evaluating someone's work: "I highly value that they've done a project and seen it through to completion. I'm not talking about publishing on Google Play, App Store, or Steam; that's irrelevant. I need to know that they started and finished what they were working on because, as I say, cemeteries are full of demos".

To Jon, completing a project says a lot about a person, like their ability to work in a team and get through conflicts.

## WELL, I HAVE THIS VIDEO GAME THING THAT'S GETTING SOME ATTENTION...

Finishing a game isn't easy; seeing a project to the end shows strong motivation. Jon explains that every project has its motivation peaks. In the beginning, you're on cloud nine, but then comes the motivational desert, the point where you really have to build the game. Still, it's all worth it for that final peak of happiness when you're finishing everything up and can finally enjoy it. Careful, it's still hot off the press!

#### YOU CAN'T ALWAYS FOLLOW THE TRENDS

We live in a world where emerging technologies change daily, and ten years ago, we couldn't have imagined where we are now. But Relevo can't afford to be at the cutting edge. Why? Because in recent years, everyone has seen these trends come and go. "Not long ago, people talked about the metaverse as if it would revolutionize all industries. What happened to it? Suddenly, it disappeared, and nobody talks about it anymore, nor NFTs, nor cryptos. If Relevo had bet on any of those trends, we'd be shut down by now".

These are the things for big tech companies. Those companies can bet it all on a trend without suffering severe consequences. Jon is clear on how to handle





## IT'S AN EXAMPLE OF HOW LOCAL CULTURE CAN ALSO BE SHARED

these technological trends: watch them and learn from them. "In the end, everything around you affects you, so you need to stay up to date and see if you can adopt anything from what the big companies do, learn from their successes and failures, and try to improve".

For now, however, they're focused on what they do best: creativity, communication, and game design.

### OVERCOMING THE SMOKE OF MISCONCEPTION

Gamers have gone from being called "geeks" to having their own leagues and being professional athletes. Who would have thought this 30 years ago?

Finally, people who played games in arcades behind clouds of smoke can enjoy their favorite games without judgment, which is great! Everyone plays video games now. And likewise, everyone is making them. Does that mean video games are becoming cultural? As expected, Jon thinks they are.



He highlights three games from Relevo's catalog to argue this point. The first is *Treasure Rangers* (2019), and as Jon says, "there are things that make this game quite different." It's a puzzle and platform game where players must combine the skills of the main characters (Lucy, Eric, Roxy, and Randy) to keep progressing. Sounds good, right? And that's not even the best part. Relevo's goal with this game was to normalize. Normalize what? Well, to normalize the fact that Randy, who is a boy with autism, is just another player. Jon reveals that it was very important for him that the game be for everyone, not just for people with autism, and that it avoided the usual heavy-handed explanations of someone's differences. Everything feels very natural. He tells us, "It's a game to raise awareness

among people about these types of conditions, where we show that everyone has their own abilities and strengths". Another standout is *Frontball Planet* (2017), which, like *Treasure Rangers*, was developed in collaboration with PlayStation Spain and focuses on Frontball, one of the Basque pelota disciplines (even endorsed by FEPelota and the FIPV). Although it's not exactly Basque pelota, the game has raised awareness about the sport and even includes a Bilbao setting, where, of course, it's raining. "It's an example of how local culture can also be shared, and while in this case, it's a sport, it could apply to other areas."

Lastly, there's *Bullfighter Neon* (2023) or, as Jon puts it, "a crazy thing". In this game, the protagonist finds himself in a futuristic, dystopian world where, in Pamplona style, he has to face off against bulls. But these aren't just any bulls. No, these are robot bulls armed with rockets and lasers: a crazy, thrilling twist. With this game, Jon talks about video games as art forms where each person can interpret the game in their own way. And although he's had a few critiques from that 1% of people who have strong opinions about bullfighting, it's a game that's been very well received and has gotten great reviews. There's always someone on Twitter who...

### THE FINAL BOSS

All of this has led to Jon being named one of the 100 developers making the industry and the world a better place, a list compiled by GamesIndustry, of which Jon is very proud, and rightly so. Plus, they just announced that they'll be responsible for creating the video game for *Terrier*, the trending horror film franchise worldwide. So, if anyone is hungry for more... we encourage you to dive into Relevo's fantastic worlds, places full of fantasy, inclusion, and, of course, endless fun.

## IF YOU THINK YOU ALREADY KNOW IT ALL... THEN YOU KNOW MORE THAN I DO





# EASQUE DANCES TO THE RHYTHM OF MATHEMATICS

BY JUDITH RIVAS (UPV/EHU) / ILLUSTRATION DOM CAMPISTRON

Basque dances and mathematics in the same sentence? Those of us in the field of mathematics love to brag that math is everywhere, but does that include dance? Maybe I'm pushing it a bit, am I? Let me show you how dance, particularly Basque dances (or *euskal dantzak* in Basque), relate to various areas of mathematics, some well-known and others... not so much.







## THERE'S NO DANCE WITHOUT MUSIC

To dance, music is essential. Dance steps match the rhythm of the music, and that rhythm consists of measures, which are the mathematical way of marking the duration of sounds. Just look at how they are represented: with fractions. We have the  $\frac{2}{4}$ , the  $\frac{4}{4}$ ... The denominator is always a power of 2, and the higher the value, the shorter the duration of each note. The numerator tells us how many notes make up each measure.

In the music of Basque dances, there are two uncommon measures that stand out: the  $\frac{5}{8}$  time signature found in the *zortziko*, and the  $\frac{6}{8}$  time signature of the *Ezpata Dantza*, where it alternates with  $\frac{3}{4}$  time.

## DANCING AT THE COMMAND OF GEOMETRY

In choreographed dances like ballet or Basque dances, dancers arrange themselves in a more or less orderly way in the performance space. When we imagine lines connecting their positions, geometric shapes start to form.

In Basque dances, circles appear frequently. For example, in the *Ezpata Dantza* of Xemein, twelve dancers (*dantzaris* in Basque) form a circle, with another *dantzari* standing in the center. In the *Zinta Dantza*, eight *dantzaris* form a circle around a central pole.



Polygons are also common. Often, dancers stand in two parallel lines, creating a rectangle. This happens in Basque dances, but here we're a bit more creative and can even see pentagons, like in *Brokel Dantza*, where one *dantzari* leads eight others arranged in two parallel lines of four. In *Txotxongilo*, we even see a hexagon: four dancers line up centrally, while the others are arranged two per side, forming a hexagon when we connect the outermost dancers' positions.

## PERMUTING AND COMBINING DANCERS

Combinatorics is a branch of mathematics that studies the possible ways to order and group elements in a set. For this, each element is assigned a number: 1, 2, 3...

A permutation is a reordering of a set of elements, represented by listing those elements in the new order. Let's look at an example: if we have the set {1, 2, 3}, all possible ways to arrange these numbers are: (1 2 3), (1 3 2), (2 1 3), (2 3 1), (3 1 2), and (3 2 1). Each of these is a permutation, and with three elements, we see there are six distinct ones.

## COULD IT BE TRUE THAT MATH IS REALLY EVERYWHERE?

Permutations appear in the *Zortzinango*, part of the *Dantzari Dantza*, a traditional dance from Durangaldea involving eight dancers. These eight dancers stand in pairs, one behind the other in two parallel lines, and they change positions throughout the dance. Let's assign numbers to the dancers' positions, starting with the leftmost in the front pair and moving left to right and front to back. With the dance's first movements, the two front pairs of dancers, who form a square's vertices, switch places with the dancer at their opposite corner



## BRAIDS, MATHEMATICS, AND DANCE

To braid, we divide the hair into three strands and weave them over and under in an orderly way. There's even a branch of advanced algebra that studies and generalizes braiding: braid theory. In braid theory, we have a set number of strings hanging from an imaginary bar and study the patterns formed when they cross over or under one another. These crossings are treated as elements in a set, forming an algebraic structure known as the "braid group." If that imaginary bar is a circle instead of a straight line, the last strand can cross with the first, forming what's known as a "circular braid group."

Two dances incorporate braiding with colored ribbons instead of hair strands. In *Iruleak*, eight pairs of dancers hold ribbons and alternately pass them over or under the pair next to them during the dance. If these ribbons were attached to a bar behind the dancers, we could see how a braid in the colors of the Basque flag is formed. This braid can be described mathematically using braid group notation. In *Zinta Dantza*, each dancer holds a ribbon hanging from a central pole, passing it over or under the ribbon of the dancer beside them. The circular braid formed around the pole once the dancers finish the first part of the dance is clearly visible and corresponds to the circular braid group.

As promised at the start, I've shown you some connections between mathematics and *euskal dantzak*. The relationship between dance and geometry is probably the most visible. But we've also looked at some lesser-known branches of math, such as combinatorics and braid theory, which surprisingly link to some Basque dances. Could it be true that math is really everywhere?

of that square. The same happens with the dancers in the rear. This permutation is represented as (4 3 2 1 8 7 6 5) because the dancer in the first position has moved to the fourth, the dancer in the second position has moved to the third, and so on. Then each dancer swaps with the one beside them. This permutation is (2 1 4 3 6 5 8 7). Here's a challenge: can you figure out the next permutations associated with the dancers' movements? You'll be able to watch the *Dantzari Dantza* in the QR code, try to write out those permutations!



Combinatorics also studies the different ways of choosing a specific number of elements from a set. For instance, from the set {1, 2, 3, 4}, there are four ways to select three elements: {1,2,3}, {1,2,4}, {1,3,4}, and {2,3,4}. If, instead of four elements, we have an arbitrary number  $n$ , and we want groups of  $k$  elements, we have combinations of  $n$  elements taken  $k$  at a time. In the *Binango*, another part of the *Dantzari Dantza*, only two of the eight dancers perform simultaneously, but which two are dancing changes throughout. Here we have combinations of eight dancers taken two at a time. Something similar happens in the *Launango*, where four dancers perform simultaneously, giving us combinations of eight dancers taken four at a time.





# Beyond Clicking



# orload



BY ATHLETIC CLUB / ILLUSTRATION RAYÉN GONZÁLEZ DOMINICI



Over the centuries, society has continuously evolved, changing habits, customs and building new ways of doing things. These changes have primarily been based on science, which has allowed us to progress in various fields and broaden our understanding of why things happen.

## A TEAM EFFORT

Many people have asked questions that were unconventional for their time, leading to new ways of thinking and, ultimately, to insights and new paths that advanced our understanding.

For those of us working at Lezama, that's what matters most: to pose different questions about the processes we develop and to share with all our professionals the doubts and uncertainties we face in working with our players. This is our way forward.

In this progress, technology (and particularly the advancements in recent years) has given us access to vast amounts of information, previously unimaginable.

Learning a sport like football connects us with human nature and provides a rich, varied context of developmental experiences, giving us a great responsibility as a Club and as professionals to co-design and live out this day-to-day growth.

## THE TECHNOLOGICAL BENCH

Years ago, the Club established a Department of High Performance staffed by professionals from diverse fields. Their goal was to understand what happens to someone when they play and interact with their teammates and opponents. They have a space to ask questions, generate hypotheses, and research various scenarios.

The High-Performance Department brings together areas such as Medical Services, Physical Training, Psychology, Nutrition, Physiology and Sports Science. Across these fields, the use of

new technologies has experienced a revolution in the last 20 years, allowing for efficient data collection and practical application.

## WHAT'S THIS GADGET FOR?

One prominent example is GPS technology, which measures the external load exerted by players during training and matches. This data is crucial for coaches and trainers, helping them understand and describe the physical efforts of players. Wearing a device on their back to track performance has become routine for our players, although it would have been unthinkable just a few years ago. That's why it's important to educate them on how technology can support their athletic development.

## A one-of-a-kind club known for its unique approach to competition and, perhaps most notably, for providing real opportunities to players from Lezama

But GPS is not the only technology used at high-performance centers like Lezama; each department uses various resources to enhance their work. Diagnostic tools include force platforms, ultrasound machines, and integrated camera systems, all of which assess players' functional, structural, and biomechanical aspects.

The market offers a wide range of tools, each with its own dedicated app. This creates a significant challenge for academies and clubs today: integrating data into platforms



capable of receiving information from multiple sources. At our Club, we're currently undergoing a process of change and adaptation to a sports management tool that will allow us to access all the information we have on our players in just three clicks.

## INFORMATION THAT SERVES A PURPOSE

This vast amount of data from cameras, sensors, geolocators, analyzers, photocells, heart rate monitors and more needs to be understood and interpreted. Football is a complex sport where players make decisions in each situation to solve motor challenges, and these actions generate data that we study afterward, not the other way around. One short-term challenge is contextualizing and linking insights from different data sources obtained from various applications.

Moreover, technological advancements allow us to explore new pedagogical and didactic strategies, creating a context where we can connect more directly with both players and coaches. By adapting to the complexities and particular situations we encounter, our Methodology Department, in collaboration with other areas of the Club, strives to create various scenarios that foster growth, self-awareness, and critical thinking for both players and coaches.

Through the personal objectives program implemented by all our athletes, we can illustrate the role that technology plays. Using various hardware and software, we establish different channels for gathering data and for analyzing, reflecting, evaluating, and co-designing diverse learning contexts, both on and off the field.

This is made possible thanks to the contributions of the Technological Development Department, which allows us to put different ideas into practice. Understanding

the complexity of human development and our own sport, we view technology as a tool to implement various measures, such as player support and engagement with their families or guardians, a critical element in personal development.

Additionally, analyzing different contexts enables us to create autonomous scenarios for young athletes, helping them understand themselves both individually and as a team. Another initiative we're implementing is a multifaceted evaluation process (including self-assessment, external assessment, and co-evaluation). For instance, we look at the interaction and communication between players and within different relationships, as well as the connections established during the game—motor development, coordination, positioning, distances, and even the emotions that drive or hinder our individual and collective performance on the field.

Technology-based learning processes help us see learning as action, connection, and practical execution within the context of the game. These processes help us establish different points of connection, opening endless possibilities to meet the demands of our players and coaches. And we will continue to grow in this way.

And perhaps most importantly, we never lose sight of where we are and who we are: Athletic Club, with 126 years of history, a one-of-a-kind club known for its unique approach to competition and, perhaps most notably, for providing real opportunities to players from Lezama, something that, ultimately, would not be possible without technology.







# Between nets and data the technological revolution in fishing

BY GORKA GABIÑA, AINHOA CABALLERO, ELSA CUENDE, IÑAKI QUINCOCES (AZTI)  
/ ILLUSTRATION SARA BETULA

Fishing, with origins dating back more than 40,000 years, is a prime example of adaptation and resilience. From primitive nets made of plant fibers and bone-carved hooks to today's sophisticated technologies, fishing has always reflected human ingenuity and the drive to innovate.



Today, the use of technological advances is essential on fishing vessels, both for traditional boats from the ports of Bizkaia (from Zierbena to Ondarroa) and for the sophisticated freezer tuna boats from Bermeo that navigate more distant waters. This technological transformation, or “technological revolution,” goes beyond constructing next-generation vessels; it also includes implementing digital solutions that improve operational efficiency and promote sustainable fishing practices.

### DATA FOR MORE EFFICIENT FISHING

The ability to measure various variables on fishing vessels is of utmost importance. Processing this information and integrating it with data from different sources (such as oceanographic and meteorological variables) allow for a deeper understanding of the phenomena associated with fishing, thereby optimizing various operations on a fishing vessel. Machine learning models applied to these data sets enable systems to learn and continuously improve data interpretation, with the aim of further enhancing fishing efficiency. That’s why artificial intelligence has become a key ally in evaluating and monitoring fishing processes.

Several applications can process large amounts of onboard data to train learning models, improving fishing techniques, onboard safety and comfort, energy efficiency, decision-making by predicting favorable fishing areas, monitoring protected or unwanted species, and implementing avoidance operations. One example is the control and tracking of onboard catches through electronic monitoring systems using computer vision. However, developing these learning models is still in its early stages due to the limited data currently collected onboard. Another potential use of the data generated is analyzing multiple environmental parameters, such as catches,

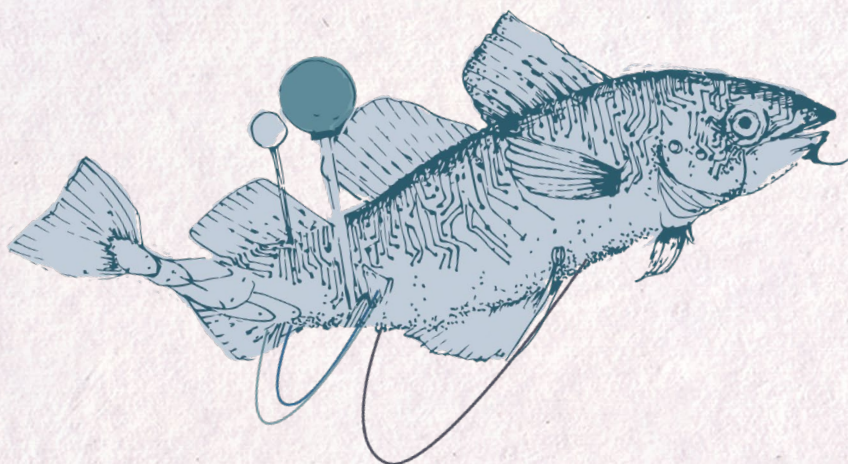
consumption, and environmental variables, to develop predictive models for favorable fishing zones. These models become more precise with larger data sets, providing more reliable predictions for onboard decision-making.

On the other hand, real-time detection and identification systems for populations provide essential information to research centers to advance their studies and enable authorities to set fishing quotas that benefit both the marine ecosystem and the local economy.

### MORE TECHNOLOGY FOR FEWER RESOURCE NEEDS

Given the current climate change paradigm, setting goals to help mitigate and adapt to it is essential. Climate neutrality is a factor that also applies to fishing activity. Technology, and especially the development of digital monitoring systems that automatically characterize operational and fuel consumption patterns, supports decarbonization strategies by improving energy efficiency and exploring innovative solutions like new fuels or alternative propulsion systems.

Moreover, the adoption of circular economy strategies to reduce waste in fishing activities is gaining momentum and will need to be addressed in the coming years. This includes reusing and recycling materials, implementing sustainable fishing practices, and reducing waste through advanced processing and preservation technologies. Furthermore, collaboration among governments, industries, and fishing communities will be crucial to developing policies and practices that promote sustainability and resilience in the fishing sector in the face of environmental challenges.



### MORE SELECTIVE CATCHES FOR RESPONSIBLE AND SUSTAINABLE EXPLOITATION

Reducing the impact of fishing on marine biodiversity is necessary to maintain the balance and protection of marine ecosystems. Improving the selectivity of fishing gear — that is, enhancing the ability to capture only commercially valuable species and avoid unwanted ones — is key to complying with the regulations set out in the Common Fisheries Policy.

## Fishing has always reflected human ingenuity and the drive to innovate

Improving selectivity focuses on redesigning fishing gear and using selection devices that, considering the animals’ morphology, behavior, and physiology, allow the capture of desired species and individuals while enabling the escape of non-target specimens. The effectiveness of these designs is tested through experimental campaigns aboard research and fishing vessels, where the catches are characterized and analyzed using statistical models. Additionally, installing underwater cameras on fishing gear to observe and later analyze interactions with different species and individuals can shed light on the effectiveness of implemented selection measures.

Reducing the bycatch of protected or vulnerable species, such as cetaceans, birds, or sharks, is a crucial, mandatory objective. However, data on their incidental capture is limited, making remote monitoring systems essential for improving our knowledge and establishing precise prevention and mitigation measures. This approach is critical to avoid generalized measures that overlook each fishery’s specific characteristics when addressing bycatch issues due to insufficient data.

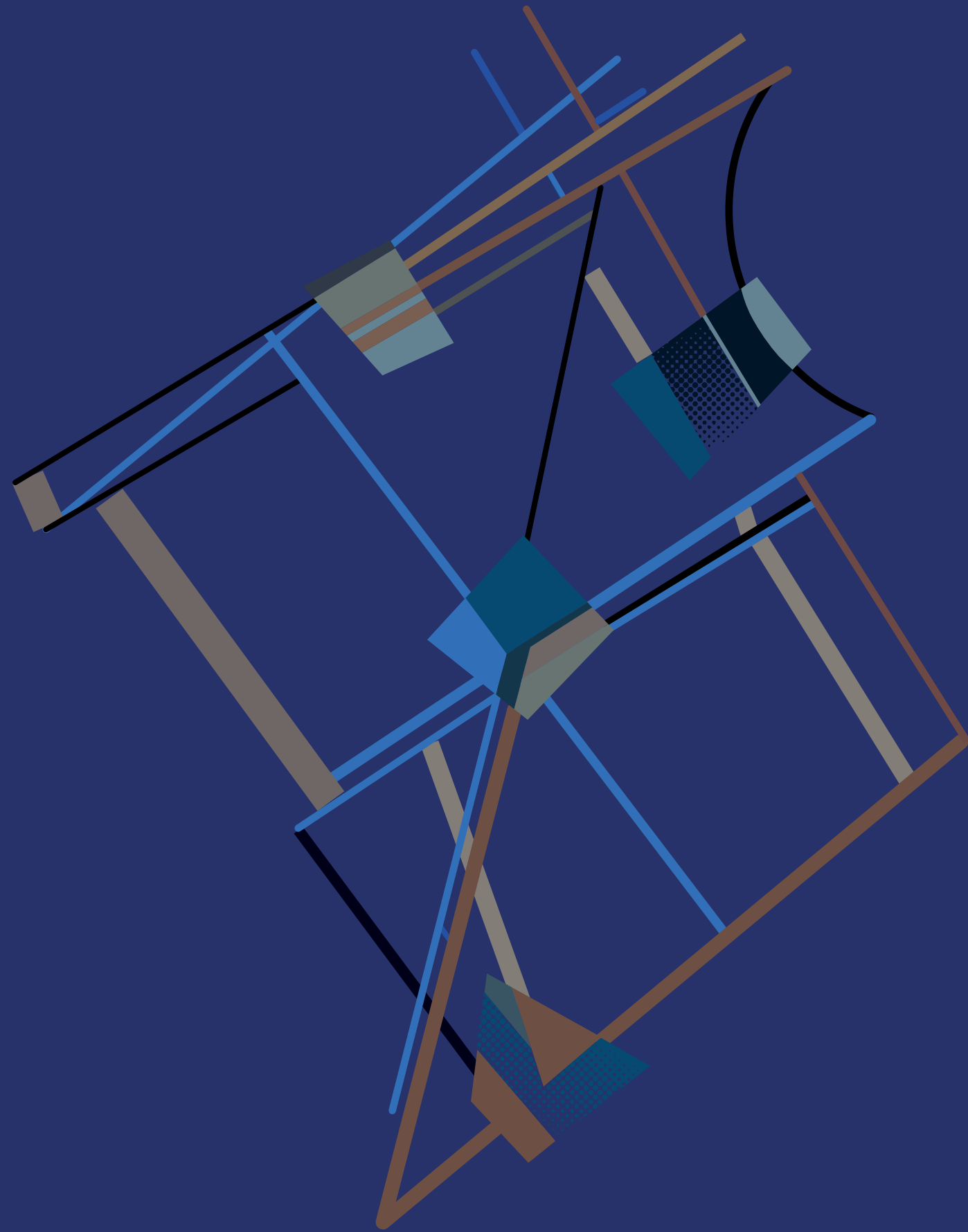
Electronic monitoring systems can also provide relevant information on the effectiveness of various deterrent or avoidance systems for protected or vulnerable species. This is the case, for example, with pingers (acoustic systems installed on boats to deter species like dolphins), whose effectiveness in certain fisheries has been evaluated and proven through thorough monitoring. This data is fundamental to ensuring the sustainability of fishing practices and the conservation of marine biodiversity.

### COLLABORATION FOR A SUSTAINABLE FUTURE

As we face challenges such as the sustainability of fishing activities, resource overexploitation, and climate change, having advanced tools to optimize fishing operations and promote more sustainable practices is crucial. In this journey toward the future, combining tradition with technology and fostering collaboration between the sector and science will be essential to ensure our waters remain productive and healthy for future generations.







# GRAPHIC MUSIC

## A JOURNEY FROM GEOMETRY TO THE STAFF

TEXT AND ILLUSTRATION BY INGE CONDE

It might seem that the only way to "see" music on a medium is by looking directly at sheet music. But what if we could see and understand sounds through symbols and non-musical shapes, even without a musical background?



## GRAPHIC MATERIAL

In this article, I will discuss my personal way of composing music, starting with graphic material. What is this graphic material? In my case, it's a set of basic symbols and colors that form a composition on paper. But first, I have to admit that this blend of the visual and the auditory isn't something I invented. Rather, it's a field that remains quite unknown, with endless ways to approach it. Just like two artists painting the same landscape will never produce identical results.

Whenever I start a new piece, I compose twice; first, I create a visual composition that I find satisfying, and then I compose music that is inextricably tied to it.

## GRAPHIC SCORES REMIND US THAT THE TWO GRAND REALMS—THE VISUAL AND THE AUDITORY—CAN COEXIST IN MANY WAYS

In my process, basic elements like lines, points, textures, geometric shapes, and colors—when combined effectively in a composition on paper—offer enough sonic and timbral possibilities for me to create music that respects the nature, density, and tension and release of these forms.

Lines can be thick, thin, continuous, or intermittent. They might stretch across the paper, connecting two geometric shapes with different textures. They might even extend off the paper, which could be interpreted musically as a sudden end to the sound associated with that element.

Dots can be large or small. They might grow to form a circle, within which we could place more lines or points.

Textures can be rough, fine-grained, wavy, smooth, or coarse. I can draw them or create a collage with textures I find in magazines.

Colors can be warm, cool, muted or vibrant, light or dark, each evoking a specific sound or even a melody or chords.

The combination and arrangement of all these elements generates what I call a "two-dimensional abstract space" on paper. Any space can be traversed from one end to another along a certain path, and these abstract spaces are no different. Instead of walking through them, we move through them with our eyes.

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### HOW TO TURN VISUAL MATERIAL INTO SOUND MATERIAL

Once I have the graphic result in front of me, a new phase begins with the goal of transforming it into sound.

First, a series of decisions need to be made. We analyze everything we have in front of us, and the graphic composition provides valuable information, offering a world of musical possibilities.

All music has a beginning and an end, so at this point, I decide on the path I'll follow across the paper to structure the piece. Musical structuring is important because it creates a timeline where musical events can be organized, sound densities can be managed, climaxes built, and so forth. Ultimately, it's about where and when things happen in a strategic way.

After this decision, I begin to associate timbres or sounds with the elements on the page. Imagine I have

three red lines ascending on the paper, intersecting with a square filled with small dots. This might suggest three distinct sounds gradually increasing in volume until they become white noise (the static sound of an untuned television). You might reach the same conclusion, which would be a coincidence. Or you might interpret it completely differently. That's the magic of these pieces; no two people would create the same music from the same graphic result.

Personally, I care that the final sound result is pleasant to listen to. Even if there are noisy effects throughout the piece, they coexist with more melodic sounds in a tonal structure.

### THIS IDEA HAS HISTORY...

The fusion of the visual and musical worlds naturally intrigued me years ago, particularly as I was finishing my studies at the conservatory.

After I had done several projects along these lines, my composition teacher introduced me to a doctoral thesis by Marina Buj, completed in 2015: *Graphic Scores and Circular Musical Graphics in Contemporary Art* (1950–2010). Marina's work focuses on teaching, research, and artistic expression.

Her thesis includes examples of drawn scores, collage scores, photographic scores, video scores, and even film scores, among others.

She presents highly varied, curious, and lesser-known works in music history, both visually and audibly. Although many of these works come from the 20th century, we can't overlook certain unique pieces that have survived to this day. For instance, works from France during a brief period known as the *Ars Subtilior* in the 15th century, when music was conceived in a unique and original—though impractical—way due to the difficulty of reading these forms. One of the most beautiful and notable scores is *Belle, Bonne, Sage* by composer Baude Cordier, a love song in the shape of a heart.

Graphic scores remind us that the two grand realms—the visual and the auditory—can coexist in many ways, presenting two artistic results that form a cohesive whole, satisfying the expressive needs of many artists, both past and present.

## RATHER, IT'S A FIELD THAT REMAINS QUITE UNKNOWN, WITH ENDLESS WAYS TO APPROACH IT



# HEY, CHATGPT, COULD YOU SING ME A BERTSO?



BY BIZKAIATECH EDITORIAL TEAM/ ILLUSTRATION RAISA ÁLAVA

We came up with an experiment... What would happen if we had ChatGPT start creating *bertsos*? It's often said that machines, or in this case artificial intelligence, could never replace human art, since it doesn't stem from personal feelings or human experiences. But is that really true?







*Bertsolaritza* is undoubtedly one of the treasures of Basque culture. It's sung poetry, full of warm and close-to-the-heart lyrics accompanied by melodies that fill our ears. You could say it's one of the most human forms of art there is. So, let's blend these two concepts.

We'll carry out the experiment as follows: we'll give the same instructions to *bertsolari* Jone Uria and ChatGPT; that is, we'll provide them with a theme, a measurement, and the number of verses. Then we'll compare their work and draw some conclusions. Who knows, maybe ChatGPT has been an expert *bertsolari* all along...

**Note:** *Bertsos* are a way of expressing oneself in Basque, and for this reason, we won't translate their content. However, we'll narrate the story below the original bertso.

**Theme:** "It's Christmas Eve, the family is sitting by the fire after dinner. Amama (grandmother) begins to tell the same story she tells every year."

**Measurement:** Habanera (8 syllables)

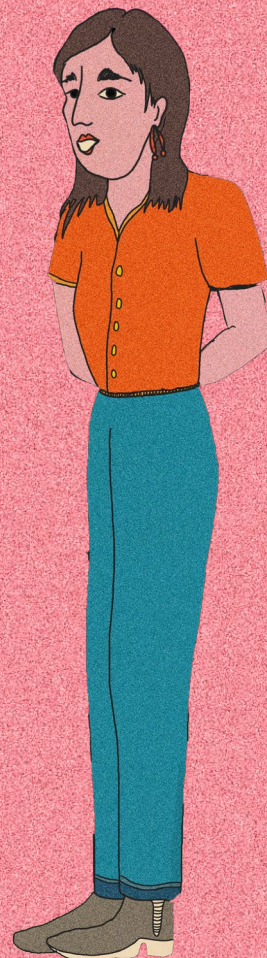
**Number of verses:** 3

#### JONE'S BERTSOS:

Berriz hasi da kontatzen  
bizipen ta anekdota:  
nola heldu den honaino  
noizbait Murietan jaiota,  
Lerinen izan zutela  
eskola eta azoka.  
Nola iritsi zen gerra  
bere batailoi ta tropa.  
Nola joan ziren Bilbora  
ta\_handik ez zituzten bota.  
Gozotegi baten egin  
zuela zenbait lan mota...  
Urtero jartzen du martxan  
kontakizunen errota.  
Denak dakizkigu buruz,  
baina ez zaigu inporta.

Aitite urteak dira  
joan zela urrutira.  
Haren historiek ere  
maiz hartzen dute kabida:  
nola gaztetan gudari  
bidali zuten mendira...  
Nola gerora bihurtzen  
zuen edozer satira:  
Bala zauri bat behi baten  
kontua zela ta tira.  
Nola\_iloben kontra ez zuen  
galdu nahi karta partida...  
Nahiz ta egoskor txistoso  
baten moduan deskriba,  
orduan etortzen zaio  
begietara ditzira.

Isilik geratu ohi da  
gero pare bat segundu,  
eta umorea eta  
ahots tonua ilundu.  
Dio mundua\_inorentzat  
ez dela betiko mundu.  
Bera\_ere beharko dela  
noizbait gugandik urrundu...  
Eta\_orduan ez dakigu  
ondo zer esan seguru.  
Baina esaten diogu  
kontsolatzea helburu:  
"lasai ze zuen bizipen,  
zuen garai, zuen gudu...  
zuek ez zaudetenean,  
guk kontatuko ditugu".

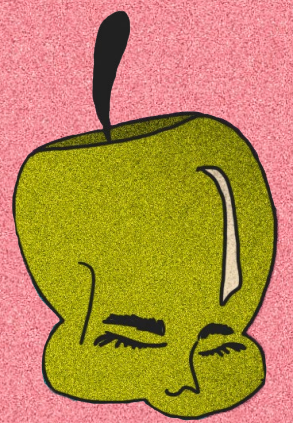


#### CHATGPT'S BERTSOS:

Gabon gaua iritsi da,  
familia dago eserita,  
sutondoaren ondoan,  
denak elkarrekin batuta.  
Afaria bukatuta,  
denak lasai hitz eginez,  
amamak hasten duenean,  
istorio zahar bat esanez.  
Urtero kontu bera da,  
denok dakigu hitz bakoitz,  
baina entzuten dugu han,  
gure artean sortuz gox.  
Amamaren ahots beroak,  
denok biltzen gaitu berriz,  
gabonetan lotzen gaitu,  
gure sustraiak oroitiz.

Kandela argiak piztuta,  
etxeak adi-adi,  
amama kontatzen hasiz,  
memoriak gogoan badi.  
Haur denborako pasarte,  
beti entzun izan dugun,  
baina urtero berriro,  
berri bat bezala irudimun.  
Denok begiak zabalik,  
hitz bakoitza hartuz erne,  
giro epel honek denok,  
lotzen gaitu betiko erne.  
Gabon gaua da magikoa,  
maitasunarekin denon,  
familia bat egiten da,  
istorioz, elkarrekin on.

Sutondoan goxo eserita,  
gure ametsak bizirik,  
amama ari da kontu,  
urtero bezala gorrizik.  
Aurreko belaunaldien,  
istorioa zabaltzen,  
etxe honen bizipenek,  
gure bihotzak betetzen.  
Oroitzapenak pizten dira,  
gure baitan barru-barru,  
eta denok isilik gaude,  
berriro entzunaz marrazur.  
Gabon gaua polita da,  
familiak osotasunez,  
gure artean biltzeko,  
amaren hitzak maitasunez.



Grandma's story always starts from the beginning. She tells us where she was born and where she grew up. She also mentions that when the war started, they moved to Bilbao, and she worked in a sweet shop. Even though it's the same story every year, we don't mind hearing it. Grandma talks about Grandpa, who passed away a few years ago; how he was sent to the mountains as a gudari (Basque soldier) and how he took everything with a touch of humor after he returned. Though she describes him as a very stubborn man, her eyes always fill with emotion when she talks about him. After that, a silence fills the room, and her voice softens as she changes her tone. Grandma says that one day she, too, will have to go, and it's at this moment that her family reassures her: even if she's no longer here, all her stories will continue to be told.



... IT SEEMS  
THAT CHATGPT  
STILL HASN'T  
LEARNED HOW TO  
CREATE BERTSOS



# LEAVING THE TECHNICAL ASPECTS ASIDE, LET'S DIVE INTO THE WARMTH AND HEART OF THE TWO BERTSOS

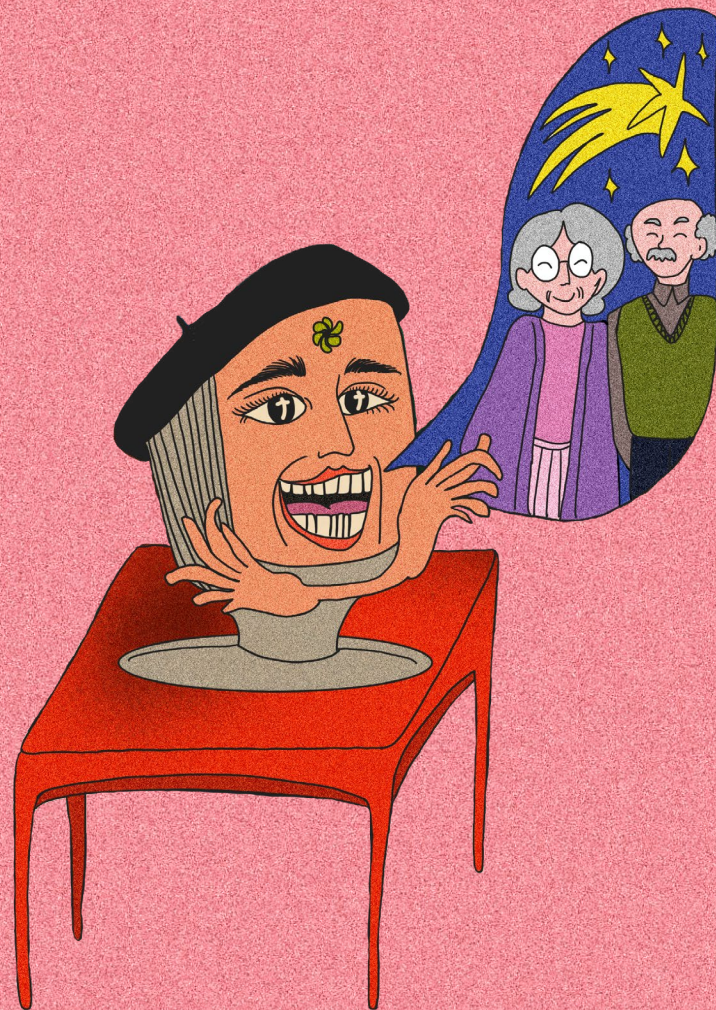
It's Christmas Eve, and the family sits gathered around the fire. Once dinner ends, Grandma begins to speak, and even though we know where the story will go, we sit and listen to what she has to share. Grandma's warm voice brings us together, reminding us of where we come from. Our dreams feel alive as we listen to the stories she tells us every year. It fills our hearts, and we sit silently, listening. Christmas Eve is beautiful. The candles are lit, and we listen to the familiar tales, letting our imaginations roam. Christmas Eve is magical, the family together, sharing stories.

What can we say... it seems that ChatGPT still hasn't learned how to create *bertsos*, or, in other words, no one has yet taught it how. We also had to cheat a little here

since ChatGPT required many adjustments to reach this final version of its *bertso*, and even then, it couldn't offer us a quality product.

The technical aspects of the *bertso* are the first thing that stand out. All of Jone's rhymes are well thought out, carefully connected. Those of artificial intelligence, however, are nothing like that. It changes rhyme every four lines, and sometimes, unable to find a rhyme, it invents new words. Does anyone know what the word "marrazur" means?

Our aspiring *bertsolari* also delighted us with a "poto": "Denok begiak zabalik, hitz bakoitza hartuz **erne**, giro epel honek denok, lotzen gaitu betiko **erne**." For those unfamiliar with *bertsolaritza*, breaking this rule is unforgivable.



The machine couldn't even calculate the syllables correctly. In Jone's *bertsos*, you can see that she sometimes joins two words with a hyphen so that phrases theoretically with nine syllables become eight, fitting with the melody. The AI decided to skip matching syllables, despite how insistent we were. Examples like "Amamak hasten duenean", "Amamaren ahots beroak", or "memoriak gogoan badi" each have nine syllables. As we mentioned, if some words had been joined, there would've been no problem, and the *bertsos* would be ready to be sung, but perhaps ChatGPT doesn't know that trick yet.

Leaving the technical aspects aside, let's dive into the warmth and heart of the two *bertsos*. Jone's *bertsos* tell a story, giving us a chance to get to know amama, aitite and the whole family. They offer glimpses of the story being told, express the interest of those around, open doors to their home, and immerse us in that warm, Christmassy, family atmosphere. She also conveys emotions like nostalgia, loss and sadness, showing how these feelings can complement each other, emphasizing the humanity in these lyrics. What did ChatGPT do in comparison? Show us the opposite.

The *bertsos* are repetitive and lack a story; it's a constant repetition of the theme we provided. It always begins by mentioning that the family is ready to hear amama's tale, and from there, the narrative becomes incomprehensible. We don't know what story amama is telling, no emotions are expressed, and it doesn't allow us to enter the festive family setting. It's completely artificial, devoid of any understanding of that atmosphere.

## EMPHASIZING THE HUMANITY IN THESE LYRICS



So, the conclusion is clear: artificial intelligence, or in this case, ChatGPT, will never be able to win a *bertsolari* competition. It will never be able to write based on experiences that a person has had or could imagine, nor can it create something that requires even a minimal degree of creativity. It will never compete with a person's work.

All that's left to do is to thank Jone for her magnificent, beautiful, and moving *bertsos*. Let's keep relying on people to create such personal works.



# THERE'S NO ART

## ARTISTS OF ILLUSTRATION



**Malen Pazos**  
Great digital illustrator known for her striking and characteristic color and texture work.  
@malen.pazos



**Nahia Iglesias**  
Illustrator and tattoo artist who blends artistic experimentation and digital techniques with an explosion of color.  
@marrabila



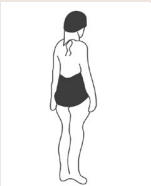
**Alberto Muriel**  
Illustrator specialized in graphic storytelling and live drawing at events. You can also see his drawings in comics, books, magazines, albums, and various walls.  
@almuriel



**Laura Arrue**  
Graphic designer and digital illustrator. Vibrant colors, charming characters, and always, a dog somewhere.  
@lauraarrue



**Josean Morlesín Mellado**  
A professor at the Faculty of Fine Arts at the University of the Basque Country (UPV/EHU), collaborating on illustration, comic, and graphic design projects.  
@joseanmorlesin



**Leire Llano**  
Multidisciplinary artist focused on graphic and audiovisual creation. Her work explores the hybridization of various artistic languages and practices.  
@leirellano



**Ainara Azpiazu Arduriz**  
She specializes in children's literature and murals. She's published comics in the most relevant magazines in the Basque Country.  
@ainara\_azpiazu\_aduriz\_axpi



**Dani Maiz**  
Illustrator works for advertising, newspapers, magazines and books. His work is conceptual, with bright colors, geometric shapes and blocks of texture.  
@danimaz



**Naizu Mauleon**  
2D illustrator and animator, she spends her free time reading, crocheting, drawing, or playing video games with a nice cup of tea, like a proper lady.  
@naizuart



**Mai Egurza**  
Studied Illustration at the School of Art and Design in Vitoria and has illustrated books, posters, comics, and games.  
maiegurza.com



**Dom Campistron**  
Dom is able to tell stories of love, solidarity and hope while claiming freedom through illustrations.  
@dom.campistron



**Sara Betula**  
Illustrator and graphic designer passionate about simplicity and the magic brought by the spontaneity of watercolor and pen drawing.  
@sarabetula



**Rayén González Dominici**  
Publicist and graphic designer, currently working at Accenture as a designer for the BizkaiaTech Magazine project.



**Raisa Álava**  
Artist and illustrator, graduated in Fine Arts from the UPV/EHU. She has collaborated in publications such as New Yorker, The Folio Society, and El País.  
@raisalava

# WITHOUT ARTISTS

## ARTISTS OF THE WORD



**Beñat Gaztelurrutia**  
A native of Abadiño, bertsolari, and manager of Gerediaga Elkarte.



**Jone Uria Albizuri**  
Mathematician and *bertsolari*. She works as a teaching researcher at the University of the Basque Country (UPV/EHU) and has traveled a long path singing *bertsos* in championships and public squares.



**Marta Macho Stadler**  
Doctor of Mathematics and Professor at the University of the Basque Country (UPV/EHU).



**Uxune Martinez**  
Sociologist with postgraduate qualifications in Advanced Human Resources Management and Organizational Communication. Specialized in science communication and Managing Director of the Chair of Scientific Culture at the UPV/EHU.



**Azti**  
A scientific and technological center that develops high-impact transformative projects in collaboration with organizations aligned with the 2030 SDGs.



**Inge Conde**  
Graphic designer, artist, composer and choir director. Inge collaborates as an illustrator in BizkaiaTech Magazine.  
@inkeborg



**Judith Rivas**  
Associate Professor in the Department of Mathematics at UPV/EHU and an enthusiast of dance in its most recreational form.



**Naiara Arrizabalaga**  
PhD in Mathematics from UPV/EHU. Professor at UPV/EHU and member of the research group Mathematical Analysis and Applications.



**Leticia Hernando**  
PhD in Computer Science, professor, and researcher in the Department of Mathematics at the University of the Basque Country.



**Jon Cortázar**  
Game designer and founder of Relevo, he's been creating and publishing videogames all over the world for more than 25 years.



**Athletic Club**  
Football team from Bilbao, founded in 1898, and globally renowned for its tradition of playing exclusively with players born in Euskal Herria.



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Issue 08 |

The Internet isn't just sparkles in the air



Issue 07 |

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Issue 05 |

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