CIC nanoGUNE BRTA

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nanoGUNE

THE CHARM OF THE SMALL

Elixabete Garmendia Lasa

NanoGUNE, at the Ibaeta Campus of the University of the Basque Country in San Sebastian, is a kind of international enclave, where researchers from twenty-six countries work together crossing new frontiers in the field of nanoscience and nanotechnology. The main language is English. However, the center is Basque, as shown by the name nanoGUNE, which in Basque means 'place for nano'. Nanoscience landed in the Basque Country in 2009 with the creation of nanoGUNE. Twelve years later, the center has carved its own niche in the international scientific network. Eleven people, major stakeholders and participants in the development of nanoGUNE, tell us their story, each from their own experience, thus weaving a story rich in details and nuances. Their testimonies introduce us to the seductive, invisible sphere of the nanoworld, so crucial in the development of science in the 21st century. How does the 'great challenge of the small' work on a day-to-day basis? This story gives us the answer to that question in a humble way, without forgetting that science is an infinite universe of still unanswered questions.

CIC nanoGUNE
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

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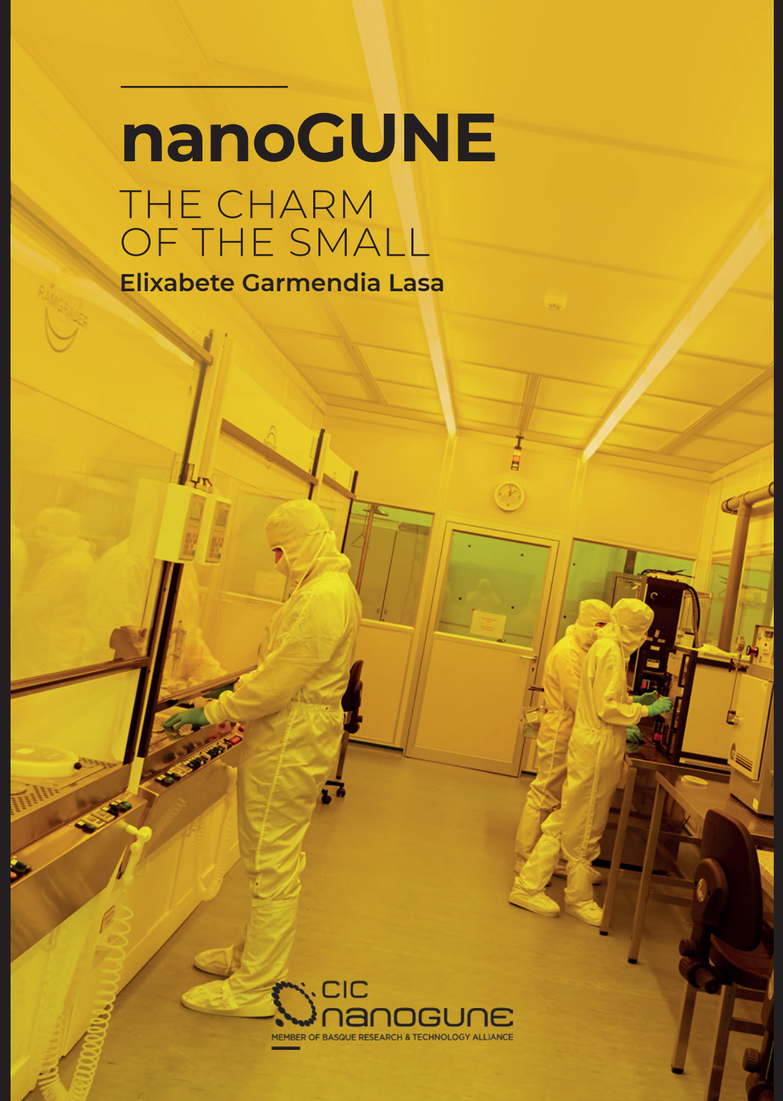
nanoGUNE THE CHARM OF THE SMALL Elixabete Garmendia Lasa



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ELIXABETE
GARMENDIA LASA
(ORMAIZTEGI, 1953)

Journalist. She worked at the weekly magazine *Zeruko Argia* (1976-1981) and at Basque Television –*Euskal Telebista*– (1986-2018). She has also worked with other media, such as the daily newspaper *Berria*, the *Argia* and *Jakin* magazines, and *Euskalerria Irratia* and *Euskadi Irratia* radio stations.

In the period 1998-2020, she wrote short biographies of eleven personalities from Basque culture for the *Bidegileak* collection published by the Department of Culture of the Basque government. She also coordinated the book *Yoyes desde su ventana* (1987), she is the author of the book and documentary *36ko gerra Ormaiztegin* (2012), and she wrote the biography *Carlos Garaikoetxea, lider bat lehendakari* (2018).

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INTERVIEWEES

Andreas Berger

nanoGUNE's Research Director since 2007.

Igor Campillo

nanoGUNE's Projects and Communication Manager (2006-2009).

Pedro Miguel Etxenike

nanoGUNE's President (2006-2019).

Ainara Garcia

nanoGUNE's TechTransfer Manager since 2018.

Juan Jose Ibarretxe

President of the Basque government (1999-2009).

Joseba Jauregizar

Director of Technology of the Basque government (1991-2008).

Miguel Odriozola

nanoGUNE's Finance Director since 2007.

Itziar Otegui

nanoGUNE's Outreach Manager since 2012.

Jose Maria Pitarke

nanoGUNE's Director-General since 2006.

Maria Rezola

nanoGUNE's Director's Assistant since 2007.

Amaia Zurutuza

Graphenea's Scientific Director since 2010.

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FOREWORD
ELEVEN PLUS ONE

On nanoGUNE's 10th anniversary, on January 30th 2009, we realized that the story of that decade was worth telling. By the time this book is published and reaches readers' hands, nanoGUNE will be twelve, which is where the original Basque title of this foreword, *hamaika gehi bat* –'eleven plus one'– comes from, using the double sense of the word *hamaika*, which in Basque means not only *eleven* but also *many*. In terms of this second meaning, our aim was to bring together many data, events, testimonies, stories, opinions, and thoughts. In terms of the literal meaning of the word *hamaika*, eleven people were interviewed: members of nanoGUNE's team and a few people who played a key role in the launching of the center.

The interviews took place between November 2019 and June 2020. In between, around February, a new guest burst into our lives, the COVID-19 pandemic, which affected the whole process and had a major impact on the content of this book. And that is why the first wave of the pandemic appears in the book, as it helped us to dig deeper into the role that science plays in our society.

This is not an inward-looking book: our aim is to bring nanoGUNE and society closer together. Why? The number of reasons is not *hamaika*, but at least they are solid ones:

One. We are convinced that we need to give a solid account of ourselves to our fellow citizens, as our center is funded by public institutions, the Basque government above all. We have always tried to make our activity part of society, and this new initiative takes place in that context.

Two. Our mission is to carry out world-class nanoscience research for the competitive growth of the Basque Country. Throughout this book, we aim to tell our society about the steps that we have taken in order to reach that goal.

Three. NanoGUNE is international. At present, researchers from twenty-six different countries are working here together. English is our common language; but nanoGUNE is here, in the Basque Country, in the city of San Sebastian. That is precisely the reason why we chose to tell our story first in Basque to then share it in other languages all over the world.

The aim of this book goes well beyond introducing our center. We would also like readers to meet the people working here, the so-called nanopeople, researchers who are often invisible to society. In fact, there is still a gap between the scientific community and the collective imaginarium that ordinary people have about the world of science. I would like to take this opportunity to acknowledge the excellent work carried out by our researchers, technicians, and members of the management team: their work has made this possible. I would also like to express my deepest gratitude to the institutions –and the people in charge– that made the opening of the center possible twelve years ago.

We were entrusted with a mission: to carry out cutting-edge nanoscience research for the competitive growth of the Basque Country. Twelve years later we can proudly say that we have more than fulfilled that mission. Many are the researchers that have passed through here, some of them now working at other centers and companies around the Basque Country. We have published in the very best journals research papers that have had and are still having a significant international impact. When nanoGUNE was in the process of being launched, we were recognized as a Consolider center and, more recently, in 2017, we were recognized as a Maria de Maeztu center of excellence, recognition given to centers that stand out for the international impact of their research activity. And all this has placed us in an exceptional position to be able to address technology transfer and, in particular, the creation of technology-based new companies in extremely competitive areas such as graphene, where we are world leaders. We also

have patents, some of them in use already, we work together with other research groups in the Basque Country and worldwide, and many companies have been able to make use of our research and of our technological services.

We have been lucky to attract twelve leading scientists, worldwide leaders in their fields. In fact, we have *eleven plus one* leading researchers, *one* of them our research director, and the other *eleven* all Ikerbasque research professors. They lead a research team of about 100 researchers, most of them rotating PhD students and post-doctoral researchers who stay with us for a given period of time. There are 110 of us altogether, ten times *eleven.* NanoGUNE is a small center, and we would like to keep it that way; but many people have carried out research at our laboratories. Indeed, during these twelve years more than 600 researchers –from 54 countries– have at some point worked with us at nanoGUNE: PhD students, post-docs, Ikerbasque and Gipuzkoa fellows, undergraduates, master students, and several guests from other research centers and universities across the world.

The Basque government's initiative, more than 12 years ago, to launch this center has paid off, although we still have a long way to go. We are convinced that we must remain committed to combining fundamental research –the kind of research whose applications are still unknown– with specific industrial research and experimental development designed to take advantage of the opportunities that can be found, at any time, along the way. That is what we have been doing with Graphenea, Simune, Ctech-nano, Evolgene, Prospero, and BioTech Foods, and that is what we are going to do in the future.

We must build on that and remain at the top. But in order to stay there, in order to stick to our path and not miss the boat, we need to keep doing the kind of cutting-edge research that will take us into uncharted territories, while still responding at all times to our commitment to industry: the industry of the present and, above all, the industry of the future. That is the big challenge of the small.

Jose M. Pitarke
nanoGUNE's Director-General
Donostia / San Sebastian, June 2020

FIRST CHAPTER
THE IDEA

THE CAMBRIDGE PROPOSAL

Everything began in Cambridge (UK), in February 2005. Txema Pitarke was a visiting fellow at Churchill College and the Cavendish Laboratory. Pedro Etxenike paid him a visit there and, over dinner, made him a proposal: founding a nanoscience center in San Sebastian, with him –Txema Pitarke– as the director. That conversation took place on February 21st 2005. The following day, Pitarke accepted the challenge.

Telling the story of the beginnings of nanoGUNE, Etxenike sets the canvas and paints the first strokes; Pitarke then fills in all details in a pointillist style.

Etxenike: When the time came to choose a leader for the center, there were several approaches; but one in particular bothered me a lot: the inertia of consultants, people telling us what others should be doing in a field in which they had never participated. They were telling us that we needed a hands-on candidate with management experience. To me, Pitarke –a theoretical physicist– was the appropriate candidate. We have always had a golden rule in our group: nobody gets a permanent position before spending a few years abroad once the PhD is completed. Pitarke had been to Cambridge UK and, also, to the USA. The electron, the neutron, and the DNA double-helix structure were all discovered at the Cavendish Physics Laboratory in Cambridge, and Txema was right there, in that lab, with a friend of mine, Archie Howie[1].

Pitarke: On February 21st 2005, the day Pedro arrived in Cambridge, we had dinner at a restaurant on Trumpington Street. I think it was the Loch Fyne, opposite the Fitzwilliam Museum, downtown, quite close to King's College. We were writing a *review* together, and we

[1] Archie Howie: british physicist, director of the Cavendish Laboratory (1989-1997).

were going to meet the following day in my office at the Cavendish to work on it. That night over dinner, Pedro said to me: "BioGUNE was inaugurated last month; the Basque government is considering doing something like that in the field of nanoscience. Would you be willing to launch a center like that?". That was his question. Pedro often goes through things quickly, and soon enough we moved on to something else. The following day, when Pedro came to my office at the Cavendish, I told him I was ready for the challenge.

They were used to working together, as it was Etxenike who had supervised Pitarke's PhD thesis. On that morning of February 22nd, they were both working on the review. The title of that paper was 'Theory of surface plasmons and surface-plasmon polaritons'. This is how Pitarke explains it:

–In a review paper, you provide an overview on the research that has been carried out on a given subject all around the world. I am proud to say this is one of our highly-cited papers; it has had a great impact on the international community. Plasmons are collective electronic excitations that occur at certain materials. When those plasmons are confined to the surface, they are called surface plasmons. Plasmons, in general, and, specifically, surface plasmons, play a key role in science and, in particular, in the development of nanoscience and nanotechnology.

Other Basque visitors were in Cambridge over those days: Roman Sudupe and Patxi Baztarrika, both San Sebastian city councillors and members of the Basque Nationalist Party. Etxenike had invited them to Cambridge. They had known each other for years. When Roman Sudupe was the president of the regional government of Gipuzkoa and Patxi Baztarrika his Chief of Staff (1999-2003), the regional government of Gipuzkoa had launched the *Gipuzkoa fellows* program. The objective of the program was to bring researchers working abroad back to the Basque Country. Etxenike, in gratitude for them having launched such a pioneering program, invited Sudupe and Baztarrika to visit Churchill College and the University of Cambridge, where Pitarke was spending a sabbatical semester.

Churchill College, Cambridge (chu.cam.ac.uk).

–The three of them –Roman, Patxi, and Pedro– came to visit me at my studio in Churchill College. Pedro wanted them to see what life was like over there; it was a bit Spartan, I must say. Afterwards, we had dinner together in a restaurant by the river.

Before leaving Cambridge, Etxenike gave Pitarke a task:

–Pedro told me: "Give a call to Jauregizar[2], make him a proposal, and we'll see what happens; the final decision is in the hands of the Basque government".

[2] Joseba Jauregizar: director of technology of the department of industry, trade, and tourism of the Basque government.

ETXENIKE'S IDEA

The original idea for the creation of a new center came from Pedro Etxenike. He says he does not really remember when and how the idea came to him, and, once again, he lays out the canvas, in this case the basis of the Basque government's science policy.

–It all dates back to president Ibarretxe's time. A number of centers were set up here during that time. I had the idea to launch the DIPC[3] when I was awarded the Prince of Asturias and Max Planck prizes in 1998, and, at almost the same time, we founded the CFM[4], which was a joint UPV/EHU[5] and CSIC[6] initiative. I had my doubts about this initiative, as in my opinion it breaches, to an extent, the Statute of Autonomy, allowing the Spanish government to hold onto powers and research infrastructures that, according to our interpretation of the Statute, should be ours. At that time, I was very close to Joseba Jauregizar and president Ibarretxe, and we used to talk about research and education a lot. We shared a number of ideas which had emerged in the 80's and have then been developed and expanded by all Basque governments since. To summarize these ideas in a few words: research policy means attracting, keeping, caring for, and sowing talent. In this context, sowing means investing in people and also in institutions, because in the long term the institutions remain. Had we not created the DIPC or nanoGUNE, we could have still had excellent personal careers; but careers do not build legacies. Institutions, however, remain, as long as they are looked after.

–So 'homes' must be built.

–Homes must be built when there is a good basis for that. Homes need good design as well as good foundations. I am an ardent defender of basic research, as without basic research there can be

[3] DIPC: Donostia International Physics Center.
[4] CFM: Centro de Física de Materiales - Materials Physics Center.
[5] UPV/EHU: Universidad del País Vasco/Euskal Herriko Unibertsitatea - University of the Basque Country.
[6] CSIC: Consejo Superior de Investigaciones Científicas - Spanish Research Council.

no applied research, no industry, or nothing at all. But in 1982 there was not enough material to start setting up basic-research centers. That is precisely the reason why we set up technology centers back in president Garaikoetxea's time, and that was the right decision. By the way, we should not forget our colleague and friend Garcia Egocheaga[7], who at that time was minister of industry of the Basque government. Basic-research centers were set up later, in 1999-2000: the DIPC and two UPV/EHU-CSIC joint centers, the Materials Physics Center, here in San Sebastian, and the Biophysics center in Bilbao. By then, we had enough people and talent; had not we created those centers, we would have risked losing top talent, people who would have stayed abroad as they had excellent offers there.

DIPC at the Ibaeta Campus of the University of the Basque Country.

–It was important then to stop the brain drain.

–Exactly! When I was awarded the Max Planck Prize in 1998 –nobody in Spain has ever received that prize–, I was given 250 000 German marks that I could spend on my research as I wished; and we used that money to help internationalize our centers. The

[7] Javier Garcia Egocheaga: minister of industry of the Basque government (1980-1983) under Carlos Garaikoetxea's presidency.

creation of basic-research centers began with Jauregizar and president Ibarretxe. The nanoGUNE project was launched later, in the framework of a specific program for the creation of Cooperative Research Centers, the CICs[8]. Jauregizar brought the CIC idea from Australia; the first CIC to be set up was bioGUNE. Together with Jauregizar and Ibarretxe, we had the idea to create something similar in the area of physics. The first thing that came to my mind was physGUNE; but the Basque government wanted to go for nanoscience and, to be honest, they were right.

–From physGUNE to nanoGUNE, more than the name changed.

–The field is now better defined, as physGUNE would have been too broad. But at the same time I used to say: "NanoGUNE must be interpreted in the widest possible sense; otherwise, fashions change, and we could end up with something too specific". In fact, nano has been interpreted in a broad and clear way, which leaves room for nearly everything.

–How would you define nanoscience?

–Nanoscience is not something totally new, although it is sometimes presented as such. It is science at the nanometer scale, the nanometer being a thousandth of a million of a meter. A large part of materials physics takes place in those dimensions, so many things we used to do were already in the realm of nanotechnology, although we did not call it that way.

THE PROPOSAL'S UPS AND DOWNS

It was June 2005 when Txema Pitarke returned from Cambridge, with his paper on plasmons nearly finished and with a new priority: the nanocenter.

[8] CIC: Centro de Investigación Cooperativa - Cooperative Research Center.

–When I returned to the Basque Country, I called Jauregizar. We agreed to meet in Bilbao, at the SPRI[9] premises. Jauregizar asked me: "So, tell me, do you know what a CIC is?". And he started telling me things. I promised I would send him a proposal; it would be a short document, just a sketch with my ideas. We wanted to promote nanoscience research, so what did we have to do? My proposal was to create a new infrastructure, which we would call the physical nanoGUNE, and, at the same time, we would work to coordinate and integrate everything that was being done in the field of nanoscience and nanotechnology at universities and technology centers in the Basque Country. That would also be integrated at nanoGUNE, but not at physical nanoGUNE; for that purpose, we would set up what we would call the virtual nanoGUNE. The DIPC would be there, as well as several technology centers and some research groups at the university. Now we organize things differently; but that is how we chose to do things at that time. Look, this is the sketch of the proposal I sent to Jauregizar in September that year.

Pitarke opens the proposal on his computer, which contains an extraordinary treasure in documentation. Back at that time, he shared his proposal with one person: Igor Campillo, who was to become one of nanoGUNE's very first employees. As a matter of fact, Pitarke and Etxenike had been Campillo's PhD supervisors. Campillo will have his say later on; for now, nanoGUNE's director continues with the story.

–In September 2005 you were working at the university.

–I was full professor at the Faculty of Science and Technology of the University of the Basque Country. In December, the Spanish government launched a new program: Consolider-Ingenio 2010. The word 'consolider' refers to *consolidated* research teams who were expected to *lead* Spanish science in a given field. The idea was to fund large strategic research projects, one per area. These would be coordinated research projects to be carried out by large consortia with the participation of a number of agents; and, exceptionally, a new

[9] SPRI: Sociedad para la Promoción y Reconversión Industrial - Business Development Basque Agency.

research center could be set up if it were considered necessary for the completion of the project. When the call for proposals came out, first I told Pedro, and then I called Jauregizar: "As we'd like to set up a new center, this would be a great opportunity for us, with a million euros per year for five years". A day or so later, I talked to Pedro again, and we came to the conclusion that it was a crazy idea, as we simply didn't have the time to put a reasonable proposal together. I called Jauregizar to tell him that we shouldn't go ahead with the proposal. A few days later, on December 28th –Fools Day in the Basque Country– while I was working at my university office in Leioa...

–Wasn't that vacation time at the university?

–During that period of time, there are no lectures at the university; but research never stops. On December 28th, Jauregizar called me and said: "We should go ahead with the proposal, no doubts on that!". My response was: "You must be crazy, the proposal has to be submitted by January 10th; no way, it's impossible". But he insisted: "Nothing is impossible!". So what could I say? He asked me to go ahead, so that's what I did! Our first meeting took place on January 2nd, at the SPRI premises. Jauregizar and I were there, as were Guillermo Dorronsoro (IK4's[10] director), Rogelio Pozo (Azti's[11] director, on behalf of Tecnalia[12]), and two consultants from Socintec: Javier Ruiz and Javier Lozano. We discussed how to structure the proposal, how to write it up, and decided who would be invited to take part in the project (nanoGUNE did not exist yet). We would ask Pedro to be the coordinator; I would be the co-coordinator; we would also ask Txema Asua (Polymat's[13] director) to participate, and a few technology centers would be partners as well: Ceit-IK4, Cidetec-IK4, Inasmet-Tecnalia, and Labein-Tecnalia.

[10] IK4: alliance of technology centers.
[11] Azti: technology center.
[12] Tecnalia: corporation of technology centers.
[13] Polymat: university institute of the University of the Basque Country.

–All those people took part in the proposal?

–Yes. Socintec sent me the first draft. I forwarded it to Txema Asua; I think he was skiing in the Pyrenees at the time, and he said: "We still have a lot to do!". So at that point I started to work on the draft, and, in the end, with everybody's help, we put together a good proposal. Pedro asked the people at the DIPC and the Materials Physics Center for help: Javier Aizpurua and Daniel Sanchez-Portal contributed a lot. The project was not just about the concept of a new center; it was also about coordinating all the participating research groups, which would lead to the creation of the virtual nanoGUNE. Integrating everything was not an easy task. Also, there was a crisis with...

–With Jauregizar?

–Yes. The proposal had to be submitted by January 10th, a Tuesday, and the day before I was told that Maria Aguirre, representative of the Biobasque agency, had said we should not include anything about nanobiotechnology in the proposal. At 5pm I had a meeting at SPRI, in Bilbao, with Joseba and Maria; the following day, January 10th, they were going to send me a proposal. That morning there were innumerous emails and telephone calls. I was prepared not to submit the proposal. Everybody was nervous. Finally, towards 2:30pm, Jauregizar called me to say that I could go ahead with my version of the proposal. "So you see we know how to be flexible", he said. The final version of the proposal was taken to the post office at around 8pm, just a few minutes before closing time.

–How long was the proposal?

–The first-phase proposal was just about 25 pages long, plus many appendixes. In March, we followed up with the second phase. Pedro was the coordinator, I was the co-coordinator, and we had a few research groups with these principal investigators: Juan Colmenero (professor at the University of the Basque Country and director of CFM and DIPC at that time), Enrique Ortega (professor at the University of the Basque Country), Txema Asua (Polymat's director), Isabel Obieta (Inasmet-Tecnalia), and David Mecerreyes (Cidetec-IK4). They were to be the leading researchers of the virtual nanoGUNE.

–You must have worked long days during that time…

–Twelve hours a day maybe? Something like that. I was in Leioa, in my office at the university. Working nonstop for many hours is not a problem for me. I can keep going without coffee or breakfast, fuelled only by fruit.

SECURING THE FUNDING

The effort made to submit a proposal to the Consolider program was worth it. Only 17 projects were accepted in the whole of Spain; the nanoGUNE project was one of them, and it was the only one for setting up a new center. The proposal had a solid basis: Pedro Etxenike and the DIPC, which he had founded. That was clear in the reports that a few scientists had written about the project; indeed, the project had the referees on its side.

Etxenike followed the process closely:

–A *referee* is a person who provides a secret report. When a research paper is sent out for publication in a scientific journal, it is usually evaluated by two people who report to the editor about the validity of the work. And behind all big research projects there are also referees to write a secret report. Our referee reports were sent to us. One of them said this about our proposal: "These people will do a good job for sure". That sentence and the funding that came after it were decisive. But even more decisive was the funding we received through a specific contribution from the Spanish general state budget, which was assigned to us thanks to the Basque Nationalist group at the Spanish Congress of Deputies and the Basque Nationalist Party.

–Those are contributions assigned to a specific project, aren't they?

–Correct. In our case, the nanoGUNE project. On September 16th 2006, I was in a castle in Austria, at a homage to the great Austrian physicist Hans-Peter Winter[14]. I have often been invited to give after-dinner speeches; you know, those speeches that on the surface

[14] Winter died two months later of a heart attack.

appear to be improvised, with no notes, but that you've been working on in your head. All of a sudden, someone told me that the Spanish president at the time, Rodriguez-Zapatero[15], didn't have a majority to pass his budget; I had a eureka moment and realized that the Basque Nationalist group in parliament could use its leverage in there to help us. I called Inaxio Oliveri, then Pedro Azpiazu, and he told me: "Yes, that's a great idea, but time is of the essence!". I called Pitarke, I got a taxi at 5am from that Austrian castle, and I flew from Vienna to Madrid (first class, as there was no other ticket available). Azpiazu and I had lunch at Lhardy in Madrid, very near the parliament. I explained things to him, he understood everything really well… and thanks to that we ended up getting 15 million euros. I had a hard time too…

–With whom?

–With a few Spanish scientists. They claimed that Basque scientific centers were being financed by spurious interests. I argued that there was no reason to think –even from a patriotic point of view– that funding the INL in Braga[16] was strategic while funding nanoGUNE –as good or even better– would represent a spurious project to secure the support of the Basque Nationalist Party in order to get passed the Spanish budget. Afterwards, one of those very scientists came to nanoGUNE's opening to take notes on how we had been doing things.

MARATHON RUNNER

At this point, Joseba Jauregizar's ears must be ringing, as he has been mentioned repeatedly. Be that as it may, he approaches the subject parsimoniously. He turns his computer on, and he opens some of the presentations he used as director of technology, including a number of strategies and programs promoted by the Basque government for industrial diversification, technology development, and research promotion. Jauregizar was the director of technology of the department of industry, trade, and tourism of the Basque government in the period

[15] Jose Luis Rodriguez-Zapatero: president of the Spanish government (2004-2011).
[16] INL: International Iberian Nanotechnology Laboratory, Braga (Portugal).

1991-2008, under president Jose Antonio Ardanza (1991-1998) and president Juan Jose Ibarretxe (1999-2008). He is a runner; he has run the Behobia-Donostia race on 25 occasions, and he has taken part in a number of marathons as well. He holds the Six Majors Marathon Medal, since he has run the six most famous marathons in the world: New York, Boston, Chicago, Berlin, London, and Tokio.

At his house in Zornotza[17], we come back to his computer presentations:

–This is a strategy for science-based industry development; it dates back to 2003, aimed at 2010. We launched two cooperative research centers: bioGUNE and biomaGUNE. BioGUNE focuses on the areas of structural, molecular, and cellular biology, and biomaGUNE focuses on chemistry and biology. We brought, to these two centers, 74 outstanding researchers from all over the world. We then followed the same model in the field of nanoscience as part of the Nanobasque 2015 strategy. The aim was to carry out top-class research in order to generate new knowledge, set up technology-based new companies, and make our industrial environment more dynamic. NanoGUNE was born in the framework of that strategy.

–NanoGUNE is a CIC –cooperative research center–, a concept that you brought from Australia.

–Every year we used to organize a trip to a place in the world that we thought interesting from the technology point of view. In the US, we visited a few centers of materials science and nanotechnology. We also went to Canada, Israel, South Korea, and Japan in order to learn about their technological developments and connect with them. On one of those trips we went to Australia: Melbourne, Adelaide, and Sidney. I was particularly surprised with the model they had been developing, the so-called Cooperative Research Centers (CRCs). I liked it. These centers focused on world-class research, high-level training, and commercialization, with scientific and technological agents working together: universities, top-class research centers,

[17] Zornotza: town in the Basque region of Bizkaia.

technology centers, the administration, and representatives from the industrial sector. There was a balance between top-class research and the exploitation of the research activity. There was a core of dedicated permanent researchers collaborating with scientists at previously existing institutions in the framework of the virtual part of the CRC. These centers had been set up in 1994; our visit took place ten years later, around 2003-2004. At some point, and we were already in touch with Pedro, we said: "We're going to create a nano research center following the CRC model".

–Who chose to use the term GUNE[18] for these centers?

–That was me, together with a consulting firm, I think it was Carlos Cuerda's firm. In that framework, the bio centers were ahead in time in a sense; and we made an important decision: to submit a proposal to the Consolider call. Pedro always consulted Pitarke; I like him a lot, he is an excellent professional. At the same time, Pedro was in touch with the Basque government, with president Ibarretxe. He explained to Ibarretxe the importance of launching a research center like this: a top-class research center that would also address the needs of industry and the health system. Pedro was not sure whether a proposal should be submitted for the Consolider program. I told him: "We're not going to wait for another call in six or eight months, this is a great opportunity to get a considerable amount of funding for the center". The new center was going to have a physical side, with dedicated researchers and infrastructure, and a virtual side. Pitarke did an amazing job putting the proposal together over Christmas; his work was excellent, and scored really high in the competition.

–The Basque government made a firm commitment.

–Once we had made the decision to launch the center, the support was absolute; the Basque government backed three CICs. Later on, the CIC fever arrived; there was a CIC for tourism in San Sebastian, tourGUNE, which was later closed; and there was a virtual CIC on machine tooling in Eibar. I think things are all right now, as we have

[18] GUNE, in Basque: place, site, nucleus.

four major research centers with international status, and we also have the events that Pedro organizes and in which Nobel laureates take part. In addition to that, nanoGUNE has a director who, on the quiet, has been doing great.

–By the way, is there any parallelism between running marathons and being the director of technology of the Basque government for 17 years?

–Yes. Holding on to the belief that you can do it.

GO SIGNAL

Applying for Consolider was a decisive step, the gunshot at the start of the race. Shortly after that, on February 28th 2006, nanoGUNE was born, and on that very day Txema Pitarke was appointed director-general. Nothing else was yet in place. The marathon had started: the whole process had to be planned quickly, as the center needed to be set up in time to be able to apply to the Etortek call of the Basque government, which accepted submissions until March.

Pitarke gives us some details:

–Applying to the Consolider call speeded things up. As soon as the proposal was submitted on January 10th 2006, the decision was made to set the center up and to appoint me director. In January, we had a meeting at the DIPC with Pedro, bioGUNE's director Jose Maria Mato, biomaGUNE's scientific director Manuel Martin-Lomas, Soledad Penades (also from biomaGUNE), and Maria Aguirre, who at the time was in charge of the Biobasque agency. BioGUNE had already been inaugurated, and biomaGUNE was to be inaugurated shortly after. The objective of the meeting was to clarify whether nanobio activities would be part of the new center. Maria believed that those activities should be separate from nanoGUNE, as there were two bio centers already; but I thought it was important for us to target the nanobio area as well, as it plays a key role in the development of nanoscience and nanotechnology, a field where various classical disciplines –physics, chemistry, biology, and materials science– merge together. After the

meeting, we went for lunch at San Martin, a restaurant on the road to Igeldo, next to the funicular station. Maria and I returned to Bilbao, in my car, and we discussed the legal framework that nanoGUNE should have. BioGUNE and biomaGUNE were non-profit associations; I then realized that under this legal status we would need a chair. I said to Maria that Pedro would be an excellent president. She thought this was a good idea.

–How about Etxenike, what was his reaction?

–On February 1st, I wrote an email to Pedro: "It would be good to leave the presidency in the hands of the DIPC, so nanoGUNE's president would be the DIPC representative, and that's you!". Pedro replied: "Mm-hmm... I'm not sure". He used to say that he wanted to give things up, not take on new responsibilities... "OK, maybe I can do it for a couple of years". I told Jauregizar, and he thought it would be a great idea, of course. A few days later, on February 14th, we had a meeting at SPRI with a lawyer from LKS[19], Martin Recalde. Present at that meeting were IK4's director-general, Guillermo Dorronsoro, Txema Villate from Tecnalia, Jauregizar, and myself. The founders of the center would be the DIPC, IK4, and Tecnalia; as would be the University of the Basque Country, but the university would come in later on; the rector of the university, Iñako Perez-Iglesias[20], and the vice-rector of research, Miguel Angel Gutierrez, would take the proposal to the university governing board. During that meeting on February 14th, it was decided that the president of the new association would be Pedro Etxenike; Tecnalia would take on the vice-presidency, and IK4 would act as secretary. On February 28th 2006, the association was founded and I was appointed director-general. I agreed to start in my new post on September 1st that year. I would already start working on the organization of a number of things; but I would not step down from my responsibilities as full-time professor at the university until August 31st.

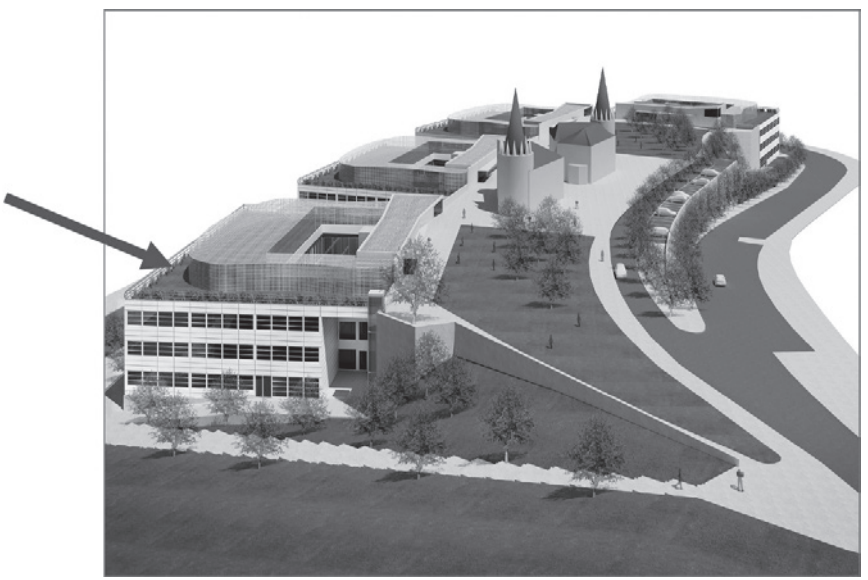
[19] LKS: consultancy firm belonging to Mondragon Corporation.

[20] Juan Ignacio "Iñako" Perez-Iglesias: rector of the University of the Basque Country (2004-2009).

WHERE TO BUILD THE CENTER

In that period of time, between February and September 2006, things kept moving and there were many discussions about the location of the center. The Basque government's idea was to build nanoGUNE at Miramon Technology Park[21]. Pitarke, however, prefered the campus of the University of the Basque Country at Ibaeta in San Sebastian. Pedro Etxenike had another idea; but it was not to be.

–I had my eye, as I had for the DIPC too, back in the day, on Igeldo Hotel at the top of the hill. I thought there could not possibly be a better place; but I have to admit that it would have been a great mistake. It's a really gorgeous place; however, in the long run, going up there every day would have been too much, and that would have set the center apart from the city.



NanoGUNE's original site project at Miramon.

[21] The official name is Gipuzkoa Science and Technology Park; but it is widely known as the Miramon Technology Park, as it is located at the Miramon neighborhood.

Pitarke takes over:

–Jauregizar and the Basque government wanted to locate the center at Miramon, as did the park's director, Joakin Telleria. There was a project to raise a new building at Miramon, and they wanted us to go there. It would have been one of the new buildings below the Arbide Towers. But here, on campus, there was another option: there was an empty plot of land, and we could well build there. The university rector at the time, Iñako Perez-Iglesias, liked the idea: he understood well what we were planning to do, and he supported the idea of building the new center on campus. I had a few meetings with Cristina Uriarte, who was the vice-rector of the Gipuzkoa Campus at the time, and she agreed with the whole idea. But Jauregizar did not like it at all. Why? First of all, because they were particularly interested in having the new center at the technology park. Secondly, he said I had no experience in the construction of a new building, so he could not trust me. (And he was right; not to trust me, I don't know, but at least it's true I had no experience at all). And the third reason was that we needed to move quick; Jauregizar thought we were going to do things at the university pace, which in his view is usually too slow. Moreover, he insisted we had to put our focus on industry, and he argued that at the university we would simply forget about that.

In the meantime, there was another factor in favor of Miramon. The Spanish government had a program, referred to as the 'Parquetazo' ('pro-park initiative') in informal talk, which offered credit for building new infrastructures on technology parks.

–That program was for technology parks only, not for universities. I tried to have this university plot of land designated part of the Gipuzkoa Technology Park, but I was told this was impossible; now they have done it in Bizkaia, with the scientific park at the university campus in Leioa. I did not want to give up; but Jauregizar had the last word, as he was the representative of the Basque government. On May 24th, Jauregizar sent me an email saying that after considering all the existing options, the Miramon Technology Park would be the best location for our center, so we had to apply to the *Parquetazo* program.

Things were rather tense. The department of industry, trade, and tourism of the Basque government insisted that the center had to be located at Miramon. Pitarke and Etxenike, on the other hand, believed that it would be a great opportunity for the nanocenter to be located at the university campus; they argued that one important point in favor of this location was the fact that scientists at the new center would be surrounded by other scientists at the university.

Pitarke explains this point:

–As for the interaction with research groups on campus, being at Miramon or MIT[22] or any other place in the world would be about the same, since what is really needed is physical, walking-distance proximity. Spontaneous, unsought collaborations, which are sometimes decisive, only happen when there is physical proximity, when people meet spontaneously. In that context, Iñako Perez-Iglesias gave to Ana Agirre, minister of industry, trade, and tourism of the Basque government, the coffee example. "Science, to a large degree", he said, "is carried out around the coffee machine". Apparently, Ana Agirre did not like the story. The debate about the location of the new center even reached the media; and, then, there was Pedro's interview on Radio Euskadi. He was asked about the location of the new center and he said: "We'll follow the instructions of the Basque government". The minister did like that, and she called Pedro immediately to thank him for his words. According to Pedro, that was the reason why the Basque government took the decision to build the center on campus. Nevertheless, the truth is that the issue remained unsettled, because I did not give up after getting Jauregizar's email of May 24th.

On September 1st 2006, the day Txema Pitarke started to work at nanoGUNE, the issue was still unresolved.

–I said to Pedro: "Look, we need to find a way out; we should have a meeting with Jauregizar, the three of us". I organized that meeting for September 25th; we met for lunch at Etxanobe, at the Euskalduna Palace in Bilbao. At lunch, Jauregizar was still talking about Miramon; he said: "The other CICs –bioGUNE and biomaGUNE– do not have

[22] MIT: Massachusetts Institute of Technology.

their own building, why should you have one? Where will we get the money from?". He was prepared to pay the rent for some space at the technology park; but he did not want us to build our own building, and certainly not on campus. We had already been granted the Consolider funding (4.5 million euros over five years), although we had not received it yet. Then, after having talked with Azpiazu in Madrid, Pedro said to Jauregizar: "And what about if we managed to get some funding from the state-budget negotiations in Madrid? How much would we need to construct the building?". "10 million", I said; and Jauregizar replied: "That's not enough; we'd also need some funding for the equipment, 5 million more". So we had to ask for 15 million euros. That was a tacit agreement. If we were able to get that funding, Jauregizar would agree to go for a new building at Ibaeta. He may have not used those words explicitly, but he accepted that with that funding we would locate the center on campus. In early December, we learned that we would be assigned 15 million euros in the state budget. Shortly after that, on December 13th, at biomaGUNE's opening event, Jauregizar took Pedro and me aside and he told us: "The Basque government has decided to build the center at Ibaeta, on campus".

Things had been tense; but everything was sorted out at the end. This is Joseba Jauregizar's version:

–When we started to develop the nanoGUNE project, the first issue was where to locate the center. Pedro had no doubt: he wanted the new center to be located on campus, at the university. At first, I tought it would be ideal to have it at Miramon Technology Park, as Miramon was less developed than the park in Bizkaia; but talking to Pedro and Txema, and after some debate, I understood that the center had to be close to the university. The vice-minister of technology and industrial development, Iñaki Telletxea, told me: "Joseba, you decide". Then I had lunch with Telletxea, and I said to him: "I think the center should be located near the university and the other centers, the DIPC and the Materials Physics Center". That's how we made the decision together to locate the center at Ibaeta. And I think we made the right decision: nanoGUNE is more effective there. This is a country of philias and phobias, it is rather provincial… I was at Tecnalia for eight years, and we had never-ending arguments about the headquarters location!

SECOND CHAPTER
THE TEAM

STARTING FROM SCRATCH

The day Txema Pitarke was going to start working at nanoGUNE, September 1st 2006, was drawing near. 3, 2, 1... Everything was at square one.

–I didn't have the money to start the new center. I applied to the Etortek program, whose deadline was March 2006, but funding didn't arrive until a year later. Would our Consolider proposal be selected for funding? We didn't know yet, and if we were granted that funding we would still need to wait about a year to receive the money. I had committed to start on September 1st; but I had no infrastructure, no money to pay salaries, no office… I had nothing! I had been appointed director to start in September; but nobody told me where I would work or what resources I would have to pay salaries, my own included. When I said this to Jauregizar, his reply was: "You're only thinking in the short term; you should rather think in the long term". So, what did I do? I went to a bank at Areeta in Bizkaia, Euskadiko Kutxa, and I spoke to the director, Javier Blanco. I said to him: "I have this project in hand; the money will arrive next year, but right now I don't have a penny". I asked for a line of credit for 100 000 euros, and 100 000 euros more before the end of the year. I was given the LOC the last week of August. On the other hand, I arranged for some office space with the director of the Miramon Technology Park, Joakin Telleria. The whole space was specifically refurbished for me, with Esther Echaniz in charge of everything, and I said to them: "I won't be able to pay until at least the end of the year". I also talked to bioGUNE's director, Jose Maria Mato, and their finance director, Alfonso Egaña; they were both very kind to explain to me how they were doing things. I had to do everything myself from scratch.

–You had a couple of employees, at least.

–Yes, Igor Campillo, PhD in physics, and my assistant Vanessa Lasaga. Vanessa had been Pedro's secretary. One day in 2006, in June I think,

when I saw her at the DIPC, she asked me about nanoGUNE. I explained things to her, and she said to me: "I'd like to come and work with you". I invited her to my office in Leioa; we talked, and a few days later, on July 7th, I made her an offer to start working with me on September 1st. I took her from Pedro, with his agreement of course. As for Igor, I had sent him my first email one year before, in July 2005, saying that I wanted to talk to him.

Igor Campillo confirms that his first meeting with Pitarke about the nanoGUNE project took place in 2005. After that, Pitarke kept him informed about the development of the project, and Campillo assisted him from the very beginning, including the Consolider proposal. And September 1st 2006 arrived. This is how Campillo remembers it:

–That was square one, when we started working at Miramon. It was simply an empty space with just a few desks; there wasn't a single computer. Nothing.

TRUST AND ROLES

Igor Campillo (Bilbao, 1971) now has a well-furnished room at the university campus in Leioa, at the main office; he has been the director of Euskampus[23] since its opening in 2011. He has a wide-ranging curriculum spanning the business sector and the university. He had been a lecturer on science and technology subjects at the University of the Basque Country and the University of Deusto, and he was with nanoGUNE from 2006 to 2009.

–You started from scratch, but you trusted the people who were behind the project.

–Yes, I did! Pitarke and Etxenike had been my thesis supervisors. I had a closer relationship with Txema; at the time, he was here in Leioa, and I used to see him on a regular basis at the Faculty of Science; Etxenike supervised the thesis from San Sebastian. I think Txema

[23] Euskampus: foundation led by the University of the Basque Country in partnership with Tecnalia, the DIPC, and the University of Bordeaux.

trusted me; he had a reference of how dependable I could be for the project. He also knew I had been working at a technology center, managing projects at Labein for six years, and that my experience would be useful for him while launching nanoGUNE during the initial phase of the project. Besides, we had always communicated very well.

–So the project was not a chimera?

–Not at all! As I was working at Labein, I was familiar with the launching of cooperative research centers; I was aware that the Basque government was very seriously behind this initiative; I was also aware of the so-called sectorial diversification strategies that the Basque government was implementing in the framework of its innovation policy. So I knew well the context in which these new centers where being set up; and the fact that the promoters of the center were Etxenike and Pitarke was for me a guarantee of success, as they are both reliable, truthful, creative... They were the best people to make a project like this happen.

–Looking at it from the outside, nanoGUNE was a thoroughly innovative idea.

–From outside, it could have sounded strange. What is that nano thing? While I was at Labein, I got involved in the world of nanotechnology. I knew that nanotechnology was one of the most important technological lines for the progress of society. I knew we had to take it seriously, not only because it was a global technology trend, but also because in the Basque Country we already had sufficient skills to tackle an ambitious project like nanoGUNE. I had no doubt whatsoever about the viability of the center, nor about how successful it could become.

–Let's go back to that very first day at Miramon: there were three of you in that empty office. What was your focus?

–It was just the three of us there. Vanessa Lasaga the secretary, Txema the director, and me a secretary too, although not in the administrative sense of the word, rather on the strategic side of things, assisting the director. Txema has an extraordinary capacity for work;

but he needed help with documentation, reports, data collection…, and that was my role. I did a bit of everything: finance, infrastructure, projects, and even communication. Later on, specific responsibilities would be assigned to the new professionals joining us.

–Talking about responsibilities, what were Etxenike's and Pitarke's roles in the process of launching nanoGUNE?

–Etxenike is quite a character in the Basque Country, he's a driving force. With his personal network and prestige, an initiative like this gets easily other people's support. Pedro also played a key role in the negotiations with the Basque government, and in putting together the international advisory committee. That's one side of it. On the other hand, Txema has been leading the overall design and strategy of the center, and he's also in charge of the day-to-day operational planning. They make a perfect team, a perfect balance; their roles are fundamental and complementary.

THE INTERNATIONAL ADVISORY COMMITTEE

Everything was urgent and needed to be done quickly back at the beginning, including the creation of an international advisory committee. That was one of Pitarke's priority tasks:

–When I started at nanoGUNE, on September 1st 2006, one of my first tasks was to settle the issue of the center's location, but the first point on my agenda was the creation of an international advisory committee. The DIPC was a good reference for this, and Pedro's contacts played a role as well. The advisory committee was put together quite quickly, as everyone accepted our invitation.

–The first meeting took place in London.

–Yes, at Imperial College, on November 28th 2006. John Pethica, Pedro, John Pendry, Jose Maiz, and myself were there. The night before, Pendry invited us for dinner. That was the only meeting which took place abroad; all the others have been held here.

First meeting of the international advisory committee: (left to right) Pethica, Etxenike, Pendry, Pitarke, and Maiz. Imperial College, London (28-11-2006).

–Can you introduce us to the people in the picture?

–Sir John Pethica, professor at the University of Oxford and founding director of CRANN[24] in Dublin, a research center which is part of Trinity College; Pedro; Sir John Pendry, who had been Pedro's PhD thesis advisor; myself; and Jose Maiz. Originally from San Sebastian, Maiz did his PhD in the US, and he then became *Intel Fellow* at Intel Labs.

–Those where the first members of the advisory committee; others joined soon after.

–Emilio Mendez, for example, who had shared the Prince of Asturias award in 1998 with Pedro; Mendez was the director of CFN[25] at Brookhaven National Laboratory in New York. And we also managed to recruit two Nobel laureates: Heini Rohrer, 1986 Physics Nobel-Prize winner, and Jean-Marie Lehn, 1987 Chemistry Nobel-Prize winner. Why did they agree to become part of our advisory committee? Because Pedro asked them, having already shown that we knew how to do things well. Having those scientists in our advisory committee

[24] CRANN: Centre for Research on Adaptative Nanostructures and Nanodevices.
[25] CFN: Center for Functional Nanomaterials.

gave our project credibility. We put together a solid advisory committee, which made it easier for us to recruit leading researchers. Later on, we brought two women into the committee: Anne Dell from Australia, biochemistry professor at Imperial College, London (UK), and Marileen Dogterom from the Netherlands, bionanoscience professor at Delft University of Technology.

Heinrich Rohrer, member of the advisory committee (2007-2013).

–What is the advisory committee's role?

–They come here once a year for a brainstorming meeting. More than anything else, they contribute ideas. Their participation and help was more intense at the launching of the center, as we were recruiting the group leaders. They helped us with the selection process. Having Pethica and Mendez on board was particularly important, as they were, or had been, directors of centers like ours. It was important for us to have their experience to hand.

The advisory committee was crucial at first, according to Igor Campillo.

–Pedro's prestige played a part there. His international contacts allowed him to bring people of renown to the committee. The chair of the committee, John Pendry, who had been Pedro's PhD thesis advisor in Cambridge, also played an important role. Pethica came from Oxford and Dublin. Jose Maiz came from Intel, a well-known company with connections to micro and nanotechnology, which was a nod to the department of industry. Heini Rohrer had been awarded the Physics Nobel prize for his invention of the scanning tunneling microscope (STM), a key tool for the development of nanoscience and nanotechnology. Lehn was another key figure, as he had won the Chemistry Nobel prize for his development of supramolecular chemistry, which is also extremely important in the field of nanoscience

and nanotechnology. A year before, in 2005, the DIPC had organized the event 'Einstein Annus Mirabilis' with the participation of six Nobel laureates, Rohrer and Lehn among them, and that too helped in terms of recruiting them for the advisory committee.

Etxenike adds:

–Putting the advisory committee together was a major step. Why did these renowned professionals accept our invitation to join the committee? Because they knew that the DIPC was working well; they knew us; Txema had been traveling all around the world; and they had confidence in the project.

Berger, Dogterom, Pitarke, Lehn, Maiz, Pethica, Etxenike, Pendry, and Mendez, at the annual meeting of the international advisory committee (2016).

BUILDING THE TEAM

At the beginning, there were three people at Miramon: the director, Txema Pitarke, the director's assistant, Vanessa Lasaga, and Igor Campillo, acting as scientific secretary. Lasaga left nanoGUNE after five months, so Txema Pitarke appointed Maria Rezola as his new assistant to start on March 1st 2007; and that very day Miguel Odriozola

joined nanoGUNE as finance director. It was not easy for Maria Rezola (Elgoibar, 1971) to explain where she worked:

–I came from Matia, a foundation for the provision of social and health services. I heard about nanoGUNE through a former colleague who called me to let me know that they were looking for somebody there. At first, I didn't know anything about the place; I knew very little about nanotechnology or research; Matia's environment was very different. I went to an interview with Txema Pitarke. He told me that it was a project; the new center had the support of the Basque government; at the time the center was at Miramon, but a new building would be built soon… It sounded like an interesting new idea, so I decided to join. I didn't really know where I was going, I know very little about the world of science; I didn't know anybody in that field. I had work experience: I had been in a company, then I moved to Matia, which was very different, and this was a new world for me. At the beginning, this was science fiction to me; nanotechnology… what on earth is that? I have to say that even now I don't always know what they're talking about: you think there must be somebody down there looking into the microscope; but then they start talking about doing things at the speed of light, and at that point you think "whoa!". Physics, chemistry, biology, it is all highly specialized, and difficult to understand for those of us who are not in the field. Even the titles of their publications: "The scale of the atom on the surface *of I don't know what…*". At first, when people asked me "What do they do there?", I tried to explain things a bit, but there's only so much you can do.

–What do you remember about the working team at the start?

–I remember that at the beginning there were very few of us. We had an office at Miramon. It was just Txema Pitarke, Igor Campillo, and Miguel Odriozola, who started at the same time as me; later on, our research director, Andreas Berger, joined us, and then the engineer Gorka Arregui. There must have been about ten of us at Miramon, no more than that. We used to have coffee together; it was like a small family. You could tell that from our conversations: "No, no, physics say…". Researchers always tend to relate everything to physics, and my reaction is: "Goodness! I do live in a different world".

Miguel Odriozola (San Sebastian, 1971) was closer to the nanoGUNE world, having come from a technology center, Azterlan, in Durango, in the field of metallurgy.

–How did they come to sign you up?

–I was working in Durango. At the time, I lived in Azpeitia; but I am originally from San Sebastian. Back then, job offers were posted in the Sunday newspapers. One Sunday, I came across an advertisement that said something like "A finance director is needed for a new research center in San Sebastian", and the advert specified that the center was nanoGUNE. As soon as I read it, I thought: "This job is a perfect fit for me! That's precisely what I am doing now; I would be happy to go to San Sebastian to work and live". And I told myself: "I need to apply". The hiring process was being managed by a company in Zarautz, Gabinete Laguntza. I sent them my CV, they called me, and I took a lot of tests. I think I went through more tests than anybody else at nanoGUNE: I took a psychometric test, which was something quite normal at the time, a technical accounting test, and I had two interviews in Zarautz and a final interview with Txema at Miramon.

–What type of training did you have?

–I did a business degree from ESTE[26] at the University of Deusto in San Sebastian, graduating in 1994. After that, I went to Madrid to do a master on financial markets. Then I returned home, I did the military service, and started to work: first in a bank, in San Sebastian, for six years; then I went to work for a company –Ihardun Multimedia– in Leintz-Gatzaga; and from there, I went to work for a technology center in Durango.

–What did you know about nanoGUNE?

–I knew nothing. At the time, the center was not even a year old; it was barely a project. I looked for information on the Internet; a few things had started to appear in the newspapers: the expectation was

[26] ESTE: Escuela Superior de Técnicos de Empresa - Deusto Business School San Sebastian.

that it would become an important center in San Sebastian; figures were discussed, the investment. It looked like a solid project. After the selection process, I was offered the job, and I was so happy! I talked to somebody who was close to Joseba Jauregizar; he recommended I take the job. I looked at the Basque government's science and technology plan, and I saw that the center was mentioned there. I realized it was a serious initiative and that the project was based on solid ground.

–As finance director, what were your responsibilities at the beginning?

–The day I joined nanoGUNE I went to the office in Miramon; I had been there only once before, the day I had the interview with Txema. I went in and Txema told me: "This is your office". There was nothing there, just a computer, a Mac I was not used to. What did I have to do? Everything. I had to do all sorts of things. What did we have at nanoGUNE back then? A bank account, accounts from six months, and a couple of official documents about the center. All of that was in two folders. As soon as I sat down, a number of things started to arrive; of course, I haven't had time to get bored ever since.

–You must have had to design the whole financial structure.

–First of all, I had to organize the accounting, which at that time was being done by a consulting firm. I planned to do it internally, so I had to purchase and configure an accounting program. It was not just posting invoices; we also had to put analytical accounting in place, so we could then justify all the funding and grants that we would be receiving: at the time, nanoGUNE was getting mainly public funds. You have to apply for grants, and then you need to manage them and justify the expenses. At the beginning, we had just a few grants; but over the years the number of grants has increased exponentially, and we now manage a huge number of them.

LOOKING FOR RESEARCHERS

NanoGUNE's core team had been put together; but it was time to look for the heart of the center: the research team. Txema Pitarke was already working on that.

–The Basque government wanted a center that would carry out cutting-edge research, would open new pathways, and would have an impact on industry. I was convinced that the new center had to do mainly experimental research. That is precisely what I wrote in my proposal of 2005. I had no experience with experimental research or with industry; I was (and I am) a theoretical physicist, I knew nothing about laboratories, and even less so about industry. How could we possibly bring research and industry together? I had no idea. So I needed to find a researcher knowledgeable in that field; and that is what I had in mind when I opened the first research position, which we called *Research Director*. I was looking for somebody with an outstanding applied-research record as well as experience in bringing research and industry together. That person would be our first group leader, and would also be the technical agent in our industrial outreach. We had to give the position a name. Someone suggested calling it director of applied research; but in the end we decided on *Research Director.*

–What is the difference between research director and scientific director?

–I'm a scientist. I didn't need a scientific director. In fact, when I called the first meeting of the advisory committee, I did so as director-general and scientific director. I don't use that term anymore, now I sign as director or director-general. What I needed was a researcher who would bring our research and industry together, and who, at the same time, would be responsible for the coordination of our research laboratories, working with me closely.

–And how did you find the research director?

–We opened the position in November 2006, a few days before the first meeting of the advisory committee. The position was advertised

in *Science* and *Nature*, and we also used our personal networks. Just three minutes after sending our email advertising the position, I got a reply from a well-known researcher saying: "I am interested in this; what is the remuneration package?". That person was, or was about to become, the director of a nanoscience center in Cambridge UK. I replied to him, but there was no follow-up after that. All in all, we received over thirty applications. After the first selection round, which Igor helped me with, we were left with a shortlist of six candidates. In December, I sent to the members of the advisory committee all the information I had about those six candidates, their CVs and some statistics. In research, you know, we do statistics in order to see how much a researcher has published, how many times their papers have been cited, how many times that researcher has been invited to give talks at international conferences, and so on. I also asked for letters of recommendation. We do that all the time; we ask for letters of recommendation from the candidates' supervisors, coworkers, and collaborators. The advice we received from the advisory committee during the selection process was very useful. I wrote to two out of the six preselected candidates, inviting them for an interview in San Sebastian. We interviewed two candidates. As both candidates were very good, we did not invite anybody else, and we made an offer to one of them, Andreas Berger.

A GERMAN RESEARCH DIRECTOR

Andreas Berger has been nanoGUNE's research director for 13 years, since 2007.

–In Novemver 2006 you saw nanoGUNE's job advertisement. Why did you apply for the position?

–I was in the US at the time, working for Hitachi. I had a good job; but some of my coworkers had left the company and I was interested in looking at other options. This was the only application I sent outside the US. As a matter of fact, my family and I, I am German, were doing well in the US, we liked living there, in San Jose at least, in California, but I wanted to see whether there were other interesting options for

me in terms of my work. And, in fact, nanoGUNE's opening for the position of research director was exactly what I was looking for. I had heard about the Basque Country; but I had never been here, and I didn't know anybody from here. I applied, and a few weeks later I received an email: "Could you come for an interview?". I went in January 2007. It was an interesting project; the people in charge were experienced and serious people… and I liked it. Of course, my profile matched the job, and I received an offer. I came back to San Sebastian in February with my family, as the entire family would be moving here. At the time, our daughter was four years old, young enough to easily move elsewhere, and my wife is Colombian but of Basque origin; her surname is Aristizabal. We liked the city, we looked at schools, apartments, prices, the city, and the overall safety, which is important no matter where you live. We liked it, and we decided to come.

–You joined nanoGUNE on July 1st 2007.

–Yes, it rained buckets that summer. It was very uncomfortable for us, as we were at a hotel; our belongings were on a ship crossing the Atlantic, and we spent one whole month at Aranzazu Hotel. It is a really good hotel; but with a four-year-old child, nonstop rain… It was a difficult situation. Later, we got an apartment on the other side of the city, at Zorroaga, and we're happy with both the lifestyle here and my work.

–How old were you at the time?

–I was 42, a good age for a change; the last change, perhaps. In the US, I had stayed for a shorter period of time in each job: two years at the University of California Irvine; three years at the University of California San Diego; three years in Chicago; six years in San Jose… All in all, I spent 14 years in the US.

–How did you feel at Miramon?

–It didn't feel that strange to me, as I'd been talking to Txema since March that year, doing a bit of work on the design of the building. When I arrived here, the first two responsibilities we had to get on with were the building and the team. In the process of designing the

building, it was important to have the input of the researchers who would be working here; we wanted to count on their experience and knowledge: we had to figure out what kind of equipment they would need and so on. For me, the priority is the team.

–How did you bring the team together?

–My question was: Is it possible to form a first-rate research team here? I didn't really know. Actually, Spain, including the Basque Country, is not ranked among the top three places for research. We aimed at building a center that would rank among the top ones around the world, and to do that we needed to recruit top-class researchers. I didn't know whether that would be possible, but it worked out. During 2007-2008, we didn't know whether we would manage to do that.

–So there was a question mark hanging over everything.

–The most important thing is to have the best possible research team. We wanted the most qualified researcher for each area; we did not need specialists for particular tools, as we didn't have the equipment yet. First of all, we needed to bring together the research team; we would form the technical team later.

–What sort of professionals did you choose?

–Physicists, chemists, a few engineers too, people with a PhD and with research experience. They had to have published good, high-impact papers. That's the kind of information we looked for in their CVs. Then, we checked their areas of expertise. There were some very good candidates who had no experience in nanotechnology, which we did not consider. We needed people with at least five years experience after their PhD. We were not looking for researchers in their 50s, as we couldn't compete with Harvard University, for example; but we were attractive for researchers in their 30s and 40s.

–Was it hard to attract talent?

–Yes… (hesitates), but not that hard. We weren't in a position to attract people from the very best universities in the world, people who were already well established; that wouldn't have worked. Our

advantage was that we had enough money to buy equipment. In research, people are not so much interested in money, in the money they make; instead, what is very important for them is to have access to first-rate equipment. Back then, in 2007-2009, we had enough money to buy the most recent, most sophisticated equipment, and that was really attractive for the researchers. We spent most of our funding on scientific equipment.

–So that was key.

–Definitely. We had to attract post-docs and PhD students who wanted to come here with us, instead of going to Cambridge for example, simply because we had excellent senior researchers and the very best research tools. The crisis was helpful there, because we did have enough funds. Companies selling microscopes and other big tools were short of customers with enough money to spend, so the situation was favorable to us in terms of negotiating prices and long-term warranties. We managed to get equipment with up to 35% discounts. Miguel Odriozola and I did that work together. The financial situation worked in our favor. Of course, we didn't think the financial crisis was a good thing; but it did happen to be advantageous for us.

WHEN R&D&I WAS A CHEMICAL FORMULA

Berger has talked about funding. The Consolider program was the first source of income; the second one was a specifically assigned contribution from the Spanish state budget. Both sources came from the Spanish government. The third piece of funding came from the Basque government. Igor Campillo followed the whole process closely.

–The Etortek program was crucial for nanoGUNE. In the framework of the Basque government's innovation policy, there was a particular tool for the development of a sectorial diversification strategy: the Etortek program. In fact, that was the program the Basque government used to fund the CICs. From the very start, there was a political commitment to nanoGUNE; but we needed to make it come into being. The research programs we had at hand for launching nanoGUNE were Consolider and Etortek; another key contribution

came through specific assignements from the Spanish state budget. I wrote the amendments.

NanoGUNE was set up when Juan Jose Ibarretxe was president of the Basque government, in the framework of the policies his government had put in place to strengthen and support scientific development. Ibarretxe received us at the Lehendakari Agirre Center, at the Leioa Campus of the University of the Basque Country. He had just come back from New York, where he had been lecturing at Columbia University.

–*Lehendakari*[27], nanoGUNE was set up during your last term at the Basque government, in 2005-2009. What was your reaction to the proposal?

–The philosophy of the project came from my friendship and collaboration with Pedro Miguel Etxenike, to whom we owe so much in this country. He came to the Basque government and to Joseba Jauregizar, who at the time was our director of technology. I am in love with science and soul, which is something Etxenike and I have discussed so many times. To a large degree, what we have nowadays, our current system for science, technology, and innovation, is due to Etxenike not as a scientist but as minister of education and culture of the first Basque government –after Franco's dictatorship–, which had Carlos Garaikoetxea as president. With no powers, at the time, in the field of R&D&I[28] and with almost no resources at all (there were no more than four centers at that time), Etxenike, with president Garaikoetxea's support, undertook a gigantic task. At the beginning of the 1980s, we invested no more than 0.069% of our gross domestic product in R&D&I. A friend of mine once said that back then R&D&I looked like a chemical formula to us: we had no idea what it was. Luckily, Etxenike had an exceptional vision, which president Garaikoetxea supported enthusiastically. Thanks to that, that 0.069% (which in Spain was about 0.3%) was multiplied by 30

[27] Lehendakari: president in Basque, usually used to refer to the head of government of the Basque Autonomous Community.
[28] R&D&I: Research, Development, and Innovation.

over the following 30 years (whereas in Spain it was multiplied by 3 or 4). That placed us in a position that at the beginning of the 1980s had seemed impossible, simply a dream. And the whole process culminated during the first decade of the twenty-first century, where we reached a technological convergence; in 2008, we surpassed the average European synthetic index of innovation for the first time.

–During your mandate, where you aware of what you were dealing with?

–I was aware that there were some central factors that have defined our country and its development. In fact, when we have based ourselves on Culture with a capital C (culture is not only artistic expression: it is narrative, values; in this case, it is a commitment to our intellectual creativity) we have had our best times. Whenever we have put Culture with a capital C to one side, when we have forgotten the importance of educating and looking after people, we have become politically dependant and economically underdeveloped. At that time, we made a commitment to Culture with a capital C; in other words, we committed to the way we understand life, business, studies, family, children, couples... And all of that was decisive. That was part of the response we could give from a local reality to a global challenge. Back in 2001, we realized that the big challenge was the challenge of the small, that global society could only be understood based on a local response. After all, we were looking at the future without forgetting our roots, because you compete starting from your roots, you innovate from you roots, you do research from your roots. That is precisely what happened here.

Ibarretxe's speech flows smoothly, without interruption. He looks into your eyes as he speaks, holding the listener's attention, transmitting his ideas and beliefs with unusual strength.

–Both Etxenike and Pitarke highlight your and your government's involvement in the launching of nanoGUNE.

–But who brought the idea to the government? Pedro Miguel Etxenike, the man who had been at the heart of the launching of our science and technology system. He might not like me saying this,

but Etxenike is one of those people who have been committed to this country, a man of science and soul. I met Txema later on, and I found him extraordinary from the very first moment I saw him, in terms of both science and soul. You need to realize that these are first-rate people internationally, people who, from their personal autonomy, have a remarkable commitment to this country. Pedro Miguel has also always been very good at choosing people to take on major responsibilities. And yes, the Basque government was very much involved: not to have been would have been just plain stupid. I was convinced this was the right decision. From the very beginning, we were fully engaged, as we knew that a lot was at stake in that decision and we had some of the best people in this journey.

THIRD CHAPTER
A TAILOR-MADE BUILDING

CLEANROOM

The nanoGUNE building is made up of seven cubes. One, at the entrance, stands upright; the other six, next to it, lie on their sides. In between, there are two terraces linking the different spaces together. Shades of gray predominate, and floating above them stand out, in blue, the name and logo of the center: 'CIC nanoGUNE' and, underneath, 'Nanoscience Cooperative Research Center'[29]. The center is on the edge of the Ibaeta Campus of the University of the Basque Country in San Sebastian. The campus starts at the Teacher Training school and ends at nanoGUNE, at the junction between Tolosa Avenue and Bernardo Estornes Lasa[30] Street. Next to it are some of nanoGUNE's 'relatives' at what is sometimes referred to as the 'Etxenike ecosystem': the DIPC and the Materials Physics Center. You cannot see it from the outside; but the nanoGUNE building hosts a number of peculiarities. The construction was very complex, as the building had to comply with certain specific requirements. The *sancta sanctorum* is the cleanroom, which leaves visitors in awe and fires up everybody's imagination: who knows what secrets of science are being unlocked in that room...

Txema Pitarke guides us through it:

–Why *clean*? Because there is no dust in it. Several filters get rid of the dust continuously. Cleanrooms are classified according to the maximum number and size of particles permitted there. For example, Class 100 is a cleanroom in which the maximum number of particles of size 0.5 mm or larger permitted per cubic foot of air is 100. The foot is an Imperial unit of length, defined as 30.48 cm. One cubic meter

[29] Since autumn 2020, that line has read 'Member of Basque Research and Technology Alliance'. This alliance, set up in 2019, brings together twelve technology centers and four cooperative research centers.

[30] Bernardo Estornes Lasa: writer and founder of Auñamendi publishers.

is the equivalent to approximately 35 cubic feet. Nanoscale devices are made in cleanrooms. Today's computer chips pack thousands of millions of tiny transistors spaced just a few nanometers apart. These chips need to be fabricated in cleanrooms.

–Could we say that cleanrooms are sophisticated laboratories?

–Yes, we could. The process of building a cleanroom, with multiple filters, is highly intricate. Cleanroom maintenance is also very expensive, as the filters need to be working continuously. Our yearly electricity bill goes up to around 300 000 euros. Then there is lighting; for photolithography, for example, yellow lighting is needed to prevent unwanted exposure of photoresists to light of shorter wavelengths. Our cleanroom is split into four bays of class ranging from 100 to 10 000. To do lithography, for instance, we use class 100 bays. And anyone entering the cleanroom needs to gown up and wear specific cleanroom suits; we look like Martians!

INSPIRED IN IRELAND

Having explained the cleanroom, now Etxenike and Pitarke explain the building's particular features.

Etxenike: The building design had to be very special. The investment was high, and we had to make sure that the building worked well in terms of equipment needs and also in terms of electromagnetic and vibration isolation. Txema supervised the whole building construction process with incredible fortitude: he was up against significant challenges, and there were many discussions.

Pitarke: In order to carry out research at the nanoscale, the scale of atoms and molecules, particularly sophisticated construction schemes needed to be developed to avoid vibrations, noise, electromagnetic radiation, and dirt, so we had to manage the construction of a highly sensitive building. I had no experience there; but I was aware that we had to take all those factors into account. I wanted to build a state-of-the-art infrastructure that could host cutting-edge research. As I

had no experience with building an infrastructure like that, I went in search of experts.

–Where did you look?

–During the first two weeks of December 2006, two major things happened. First of all, we learned that we would be receiving a specific contribution of 15 million euros from the Spanish state budget. The second thing was that the Basque government was going to give us green light to locate the center on campus at Ibaeta. The government's decision was passed on to us by Joseba Jauregizar on December 13th, the day of biomaGUNE's opening event. Immediately afterwards, I bought a plane ticket to Ireland, to Dublin. John Pethica, member of our advisory committee, had been the founding director of a new nanoscience center there in Dublin. Their building was being constructed right at that moment. I was in Dublin from December 19th to December 21st, my builder's helmet on. That center goes by the acronym CRANN: Centre for Research on Adaptative Nanostructures and Nanodevices. It is in the city center, next to Trinity College; it is part of the college; it's not an independent center. I asked if they could put me in touch with someone who might be able to help with the design of our building, and they said they could: their technical design had been done by an architecture firm in the US.

–You went straight to them?

–Yes, I did. At the time, those architects were finishing a new center at Harvard Univertsity together with the Navarrese architect Rafael Moneo. Moneo took care of the artistic side of the design, and the American architects were in charge of the technical side. The firm was 'Wilson Architects', from Boston. I called them; they suggested to first come for a visit, and they would then proceed with the project on their own or as part of a larger team. In January 2007, I negotiated the concession by the University of the Basque Country of a plot of land for the building construction. We signed the agreement on February 9th. Right after that, we published in the newspapers a tender for the building design. We put together a very solid team: Wilson Architects, an expert on vibration isolation (Michael Gendreau

from California), cleanroom experts (Abbie Gregg, also from the US), experts on electromagnetic-radiation isolation, engineers from IDOM, and architect Javier San Jose.

–It must have been a very attractive project for the architects and all the other specialists.

–It certainly was! Back then, nanoscience centers were being launched in many different places: in the US, in Europe… also in Spain, in Madrid and Barcelona for example. In Barcelona, the original project had been delivered by Javier San Jose, who is originally from San Sebastian; but that project did not continue when Pasqual Maragall left office as president of Catalonia in 2006. The center was not closed down; but the Spanish Research Council took over the building construction, and San Jose's project was put to one side.

–The architect must have been eager to remove that thorn from his side.

–As soon as Javier San Jose found out that we were going to be building a new nanoscience center in San Sebastian, before our call for tender, he got in touch with Jauregizar, and Jauregizar asked him to speak to me. San Jose called me and said: "I've got experience with this kind of buildings, so I'd like to do nanoGUNE's building design myself"; but IDOM also wanted to do our building. In fact, Mikel Guerra, director of IDOM's office in San Sebastian, also got in touch with me before our call for tender. Both of them wanted to do everything, the architectural design as well as the engineering part of the project; so I suggested they bring a joint proposal, which is what they did. They set up a temporary business alliance, and the project was awarded to them. They did not think we would need help from the American architects; but I put that on the table as well. We signed contracts in March.

–That was very fast!

–I had this huge pressure from Jauregizar. He had said to me, in the middle of the debate about the location of the center, that he couldn't leave it up to me because I had no experience and also because I

would work at university *tempo*, which he always found too slow. Jauregizar was always chasing me up: "You're moving too slow; all this would have been done quicker at the technology park", and so on. I had that pressure, for sure; but I wanted to do things well and quickly in any case.

A parenthesis opens here: I have to ask Joseba Jauregizar about all the pressure he was putting on Pitarke.

NanoGUNE's early construction works (December 2007).

–So, worried about university *tempo* you put pressure on Pitarke all the time?

–University *tempo* is often too slow, so I did push things a little bit. Sometimes you need to speed things up and move fast. In any case, Pitarke has always been a great director, an excellent professional, and he and Pedro were an outstanding team.

OBSTACLE RACING

–The project was complex and, in addition to that, you had to coordinate all these professional people. That must have been a difficult task.

–The debate was ongoing, with a few heated discussions as well. For example, the locals complained because I listened to the Americans. Starting in March and all the way through August-September, we organized week-long workshops every month. We would all meet at Miramon to work on the project and make decissions. They were brainstorming work sessions; we covered the entire wall of a large meeting room with posters detailing our discussions and decisions. We analyzed and discussed the tiniest details: what should go where, technical difficulties, strategies… Igor Campillo was there as well, next to me, through the whole project. His contribution was extraordinary.

Igor Campillo remembers their trip to the US:

–In April 2007, we went to the Laboratory for Integrated Science and Engineering (LISE) in Harvard, and we visited Wilson Architects in Boston. We also visited other research laboratories in Chicago, Indiana, and California. We traveled there with the team of engineers from IDOM, as they were in charge of the engineering side of the project. Our first meeting with the American architects had already taken place at our premises in San Sebastian, in February. The budget and deadlines were very clear to Txema, who is very methodical in that sense too; he wanted everything to be done well and quickly, and the building had to be ready in 15 months. The architects held their heads in their hands. The construction tender went to Amenabar construction company; I think Txema had a few heated discussions with them. Strict penalties about the deadlines were included in the contract. Txema is tough like that, and he made them feel it.

Pitarke set the timing for the entire process with great precision:

–The building-design tender went out in February 2007; we started the project in March, and it was finalized by July. In the meantime, we started to launch the construction tenders. In order to be able to initiate the construction before the completion of the building-design

Laboratory for Integrated Science and Engineering (LISE) in Harvard: Pitarke and Campillo in the center, flanked by IDOM engineers and architects of the firm Wilson Architects (April, 2007).

project, we split the project into various parts. The first part of the construction, which was the excavation and foundation, started in June, before the project was finished. Digging started towards the end of June 2007 and we all moved into the new building in November 2008: 17 months altogether. A great achievement! Then what happened? All the people involved, with no exception, asked for more money.

–Do you mean all the professionals involved in the building construction?

–Yes, the architects here and abroad, the cleanroom professionals, the engineers… We had some trouble with the construction company, Amenabar, because there were some delays on their side and also because they were constantly asking for more money. They usually make a competitive proposal to win the tender, and afterwards they want to be paid more. The construction world is very complicated.

–Did you manage to avoid paying more?

–We did not pay more to anybody; only when we asked for new things that were not in the project.

–Did you supervise the whole process yourself?

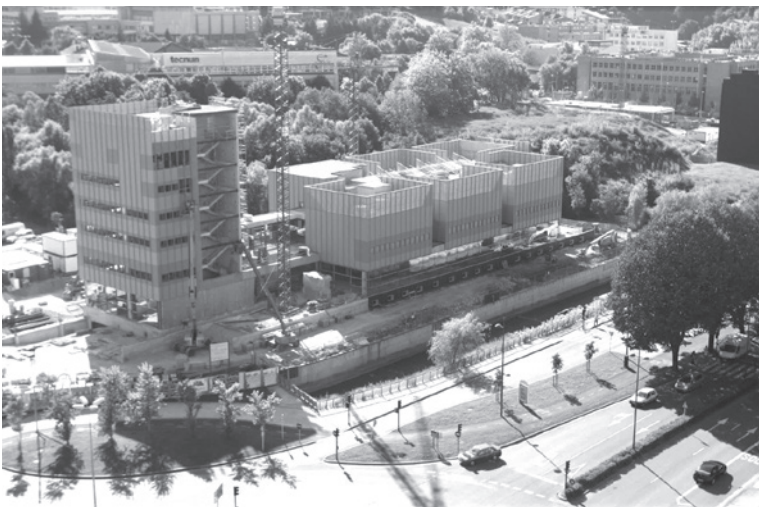
–I coordinated everything, with help from Gorka Corchete, our project manager also from IDOM. I too got help from our finance director, Miguel Odriozola, and our facilities manager, Gorka Arregui; and, mostly at the beginning, I also counted on Jose Angel Vazquez, from Labein-Tecnalia, who gave me general advice. With IDOM we had two contracts: the first one came through their temporary business alliance, with architect Javier San Jose, for the engineering part of the building design and also for the site supervision; the other contract we signed for the management of the whole project. Gorka Corchete was in charge of everything: he talked to architect Javier San Jose, to the project engineers from IDOM, to the site supervisor, who was also from IDOM, and, above all, to the construction company, Amenabar. There were some delays with the construction company; they promised the building would be completed in 14-15 months, and later they told us that penalties were never really applied. Why were they then written into the contract? We ended up on the verge of going to court. Things were very tense; but, finally, once the building had been inaugurated, I made them a proposal, and we reached an agreement. Be that as it may, it all turned out well after all. Everything was finished quickly enough, and the building has been working very well. I was also lucky to have a great working team at nanoGUNE.

At nanoGUNE, everyone contributed according to their speciality. For example, the research director, Andreas Berger, made sure that the laboratories fulfilled all the required conditions accurately.

–I talked to the architects and our technical advisors. They had a lot of experience designing this kind of buildings and, in particular, designing specific laboratories to allocate the most appropriate scientific equipment. While I was still working at Hitachi, I was already in touch with the architects, and when I came here I focused on the building construction and also on putting the research team together.

The Finance Director, Miguel Odriozola, had to manage a few million euros throughout the process.

–Yes, the financial management of the building construction was in my hands. When I came to work here, the building design was ongoing and the construction was being planned in phases, five in total. The first phase, which was the excavation phase, was assigned just a few days after I joined nanoGUNE. My contribution was to coordinate the tenders for the various construction phases: preparing and publishing the tender specifications, improving the offers, coordinating those offers with IDOM, awarding the tenders, signing the contracts, following them up, and fighting trades people so that they all met the deadlines, which was not an easy job. We had to put a guarantee into effect. Guarantees are there to ensure that contractors comply with the terms of the contract. Those were difficult times, we had tough meetings; but, finally, we managed to make everything go smoothly.



NanoGUNE's seven cubes under construction (July 2008).

–The amount of money required for the construction process was no joke.

–In that sense, we were lucky to have received a few million euros through specific contributions from the Spanish state budget, which was the result of the negotiations carried out by the Basque Nationalist Party in Madrid. In 2007, we received 15 million euros, and the following year we received 10 million euros more. With those 25 million euros we had enough to put the building up and to fit it with the best possible equipment that was available at the time. We invested around 15 million in the building and about 10 million in the equipment.

While talking about funding issues, Txema Pitarke mentions something interesting. A few years later, in 2015, nanoGUNE received a request from the Spanish government about the Consolider grant. It came from the ministry of education, culture, and sport.

–In 2006, we were granted four and a half million euros from the Consolider program, and in 2015 we received a claim on that money, saying that some of our expenses had not been properly justified. We, on the contrary, argued that everything had been properly justified; but two years later, in 2017, we had to return almost five hundred thousand euros to the ministry. Nevertheless, as we were so convinced that we were right, we took them to court. Two years later, in 2019, the judge ruled in our favor. We were given back all the money that we had returned, plus interests.

QUANTUM CORRAL

There was progress on the building, and the team was being put in place. It was time for nanoGUNE to initiate an outreach strategy, which Igor Campillo was in charge of. In fact, being a scientist by training, he had started a master's degree in scientific communication and was particularly interested in science outreach. Campillo brings us to the quantum corral:

–In my original conversations with Txema Pitarke in 2006, I insisted that it would be important for a center like nanoGUNE to take good care of communication and outward projection; Txema got that very

quickly. I also gave him the example of English-speaking centers, not only nanotechnology centers but research centers in general, as they pay particular attention to what is usually called *public outreach*. From the very moment I joined nanoGUNE, I knew I wanted to develop that dimension. At first, however, there was not much to communicate, so we focused on the launching of the center, the international advisory committee, the funding from the Basque government through the Etortek program, the recruitment of researchers, the construction of the building… I never left communication unattended; but there was not much scope to address it at that point. Txema was also aware of the importance of launching communication activities, so the very first week we started at nanoGUNE, in September 2006, we organized a workshop, a symposium, in the framework of the Summer Courses of the University of the Basque Country. That workshop allowed us to introduce nanoGUNE, for the first time, to the scientific community. Later on, we got in touch with journalists from a number of media groups: Vocento, Noticias Taldea, the SER Network, EITB… At that point, we also started to work with a small media agency that had been giving media coverage to DIPC events. The DIPC has always been very active in communication-related issues; Pedro has always paid particular attention to that. And at the same time, I started to work on a number of factors related to that field: our graphic trademark, for example.

–Which is highly communicative: nano in lower case, GUNE in capital letters.

–As the Basque government was promoting the CICs, there were two different things that needed to be included in the graphic trademark: the acronym CIC (Centro de Investigación Cooperativa) and GUNE in capital letters. That was the criteria of the department of industry, trade, and tourism. We were somehow being subrogated to the Basque government's CIC brand. Then we had to find something that would link to nanoscience, and that brought us to Heini Rohrer and his STM: with that tool you can 'see' individual atoms and you can also move them. Nanotechnology is very much about our ability to manipulate matter at the nanoscale. We were looking for something

connected with that idea, so we ended up with a logo that was inspired on the quantum corral first brought to light by IBM scientists by moving atoms one by one.

–Do atoms behave a bit like sheep then?

–Not exactly. The fence of the corral is made up of atoms, and the sheep are the electrons within the corral, which behave as dictated by quantum mechanics. The quantum corral allows us to visualize quantum mechanics. There is no more powerful image for nanoGUNE! The three little balls outside the fence represent spare atoms not used to build the corral.

Txema Pitarke provides us with more details about the quantum corral:

–The scanning tunneling microscope is basically a tip made up of a few atoms at the tip apex. At first, the STM was used to 'see' atoms on a surface, and, a few years later, in 1989, that tip was used to controllably move atoms, one by one, from place to place on the surface of a substrate. In fact, IBM scientists used 35 xenon atoms to famously spell out the letters 'IBM' on a nickel surface. Not long afterwards, in 1993, the first atomic corral was built from individual iron atoms on a copper surface. Furthermore, the electrons within this corral were shown to behave like standing waves in a pond, as predicted by quantum mechanics. That is precisely why we refer to this atomic corral as a quantum corral; and that's what we wanted to represent in our logo.

THE BIG CHALLENGE OF THE SMALL

In addition to the logo image inspired by the quantum corral, nanoGUNE has a very unique motto: 'The Big Challenge of the Small'. Etxenike likes it a lot.

–It's a beautiful slogan. The subject of the big and the small has always been topical. The great economist Joseph Schumpeter cites it too. It has a double meaning. On the one hand, physics is a tale of two extremes: the largest scale (the galaxies) and the smallest scale (the atomic nucleus). In our field, the smallest scale is represented by the

nanoscale, and the behavior of materials at a larger scale is dictated by the behavior of atoms and electrons at the nanoscale. And, on the other hand, our motto also refers to the Basque Country: a big challenge for a small country. That double meaning makes it attractive and particularly beautiful.

–Who came up with it?

–I think it was Txema; it could have been me, but I don't think so. President Ibarretxe uses it a lot in his speeches. It also connects with the past: how to build on tradition and how we rely on our predecessors. The Basque language, Euskara, is what it is thanks to Koldo Mitxelena[31] and many more, and to our ancestors who fought on when there was little hope. The same is true with respect to the current technological development of the Basque Country; we owe it to the first Basque government after Franco's dictatorship. When unemployment was at 19%, we did not say: "We need to invest to create employment here and now", which would have been a big mistake. Instead, we had the vision to invest in vocational training, in scolarships to go abroad, in science. That nationalist government opened the path to R&D, as president Garaikoetxea points out in his book[32]. That government's first program stated in 1980 that there can be no technological development without a solid scientific basis, that in modern societies there is no economic development without a solid basis for good scientific and technological education. That idea is also connected to the fact that small things from our past make us big in some respects. Think about Joxean Artze's words: "Iturri zaharretik edaten den ura, beti berri den ura..."[33] or "Izan zirelako gara"[34]; or Xabier Lete's "Gu sortu ginen enbor beretik sortuko dira besteak"[35].

[31] Koldo Mitxelena: linguist and promoter of the unification of the Basque language.
[32] *Euskadi: la transición inacabada* (Planeta, Barcelona, 2002).
[33] "The water from the old fountain is always new water".
[34] "We exist because they did".
[35] "From the same trunk we came, others will be born".

Exenike clearly has a treasure chest full of poetic and philosophical quotes. He mentions them continually throughout our interview. The motto 'The big challenge of the small', however, is not his, but Pitarke's, as he suspected. NanoGUNE's director confirms that:

–I came up with the idea while I was talking to Igor. We started to use it in September 2006, when we were working on our first strategic plan. It has a double meaning: nanoscience is the science of the small and, at the same time, our project was a big challenge for a small country, the Basque Country. We used that double meaning from the very start. I used to mention it in my talks and presentations; nowadays, in my talks at nanoGUNE I don't say it anymore, simply to avoid repeating the same thing all the time.

FIRST USE AND OPENING OF THE BUILDING

In spite of the difficulties, the time came to move from Miramon to Ibaeta and to start using the new building. Miguel Odriozola tells us the story:

–We were very well installed at Miramon and we had wonderful offices; but the Ibaeta headquarters had been built. Just as always happens in these situations, it was a never-ending story: construction trades were missing here and there, last-minute details needed to be finished… And so we made a decision: "We'll go to the new building as soon as it's got the electricity; we'll go there the day we can turn on the lights and connect the computers". And that happened on November 24th 2008. We brought our ten computers and twenty folders from Miramon. The heating system wasn't working yet because we weren't connected to the gas mains; I remember I brought an electric heater from home, it was freezing! But the fact that we were here meant heating had to be started out as soon as possible; otherwise, things would have dragged on forever.

Pitarke was not willing to give in:

–"We cannot go!" some people would say; but I insisted that we had to go: "We said we would be in the new building by that date, and that's what we should do!". I wanted to push things a bit: when

it comes to building work, you always need to have a bit of tension. "Come what may, we're going!". Pedro would say: "Pitarke took them into the building with no heating, it was freezing cold there!". But he was polite about it.

Maria Rezola remembers her curiosity more than the cold November weather:

–The first memory I have from when we came to this building is the intrigue we felt: the center had been designed by American architects; Txema and Igor had visited several laboratories in the US… It was kind of a mystery: "If they went that far, there must have been a reason behind it!". I was curious about the new building. It was a milestone. We would go down to the laboratories and wonder "What's this?". And, all of a sudden, we went from being ten people to being twenty-five, many of them coming from abroad. I remember that and the preparations for the opening.

–The opening took place on January 30th 2009. How do you remember it?

–Lots of people, and we were all nervous. We held a few open sessions for the public as well, and there was a lot of curiosity! "What's this, what's that?". You could feel the public's interest. A lot of media came too. And we felt proud: "The building is done, we're now installed here…".

Miguel Odriozola remembers the opening day as something from the distant past:

–Many people came here. I remember president Ibarretxe came to open the building, there were a few speeches by politicians, and then there was a cocktail party for our guests. It was a long day; we were all very happy to see the project come into being, as the project was really launched that very day. We had the building there, the facilities, and it had all been done in a record time. It took us less than a year and a half to put the building up. Deliberately, some areas were left as shell space for future expansion. More than the social event, I remember the satisfaction of having reached an important milestone. The researchers who had already arrived were completing their teams, and

they were also looking at the scientific equipment they would need. Back then, there must have been about twenty or twenty-five of us working at nanoGUNE.

President Ibarretxe also remembers the event:

–I remember Txema Pitarke's talk very well, he spoke in Basque and in English. It was so wonderful! I loved the things he said. I perfectly recall that day and the day ten years after as well. I cannot forget Joseba Jauregizar's human, emotional reaction to Pedro Etxenike's and Txema Pitarke's heartfelt words towards him. Joseba deserved it. He was passionate about his responsibility in the government. Life is all about passion.

Was Txema Pitarke moved on opening day?

–I am not the kind of person who gets emotional so easily, ha, ha, ha… I must admit, however, that in the middle of the speech I felt a bit of a stir, but it wasn't so bad. Basque television came, we were on live. The opening event was introduced by Pili Kaltzada; I knew her from Elhuyar[36], though at that time she was communication director at Innobasque. A traditional *aurresku*[37] was danced outside the building; but the event itself took place indoors with a few speches and, then, something to eat. Who was there? President Ibarretxe and the president of the regional government of Gipuzkoa, Markel Olano; the Spanish state secretary of research, Carlos Martinez; the rector of the University of the Basque Country, Iñaki Goirizelaia; and from the Basque government, besides the president, we had the Basque minister of industry, trade, and tourism, Ana Agirre, and the Basque minister of education, universities, and research, Tontxu Campos.

In the speech that president Ibarretxe liked so much this is how the director of nanoGUNE summarized the master lines that would guide the new center:

[36] Elhuyar: private non-profit organization pioneer, since its foundation in 1972 as a cultural association, in the development and dissemination of science and technology in Basque. In 2002, it became a foundation that now also offers a variety of services for the application of advanced knowledge.

[37] Aurresku: traditional dance to honour the ocassion.

"Nanotechnology is currently accepted to be one of the driving forces behind economic growth in the 21st century, as well as being one of the key factors of sustainability that cannot fail to mark the future development of humanity. The road ahead is long and uphill. One needs to understand new phenomena and master the manipulation of matter at the nanoscale; one also needs to be capable of designing and creating materials, devices, and systems by controlling matter at that scale. (…) In this way, and small as we are, we will be able to contribute to the creation of the necessary conditions for the humanity to benefit from a wide range of nanotechnologies".

Txema Pitarke is not completely sure, but he has the feeling that after the opening event he went on working at nanoGUNE.

FOURTH CHAPTER
RESEARCH GROUPS

FROM FIVE TO TEN

By the day of the opening of the nanoGUNE building at Ibaeta, on January 30th 2009, five research groups had been put together; five groups and twenty-five researchers coming from the US, Germany, France, Italy, the UK, and other countries worldwide. Ten years later, the center had ten research groups and around one hundred researchers from twenty-six different countries.

NanoGUNE's director has a generous office space. Two things make it stand out: a huge blackboard, filled from top to bottom with equations and calculations written in chalk; and, further into the room, by the window, a long desk turned into wall. The bricks making up the wall are folders, research papers, reports, and all sorts of documents, all placed on top of each other, some of them in one direction, others crossing each other, arranged in rows. By some miracle, the law of equilibrium is not broken. And Etxenike says that Pitarke knows exactly where everything is in that quagmire, as he can always find whatever he is looking for in that wall of papers.

When it comes to talking, the same thing is true with Pitarke. His memory folders hardly ever fail him, not even when it comes to the most specific, tiny details. Now we come to nanoGUNE's essence, the research groups: how they are put together, how the group leaders are selected, and the rotation of most of the researchers coming to the center. As we talk, we also learn about the inner workings of the world of science and research.

–To begin with, how has nanoGUNE managed to attract talent from abroad?

–At the beginning, our main reference for people coming from abroad was the DIPC. Later on, we had two references: the DIPC and our newly created international advisory committee. And once Andreas, coming from Hitachi in California, accepted our offer to

become nanoGUNE's research director, we had a third reference. All that was very helpful when it came to attracting group leaders. At the time, it wasn't easy to attract senior researchers from the US or from anywhere else. Top scientists mainly look for a solid and credible project, the right conditions to be able to carry out cutting-edge research, and having the very best scientific tools at hand. Nowadays, we have ten research groups and twelve senior scientists.

The first group deals with nanomagnetism. The group leader is Andreas Berger, the research director. In that group there is a group coleader, Paolo Vavassori from Italy. The second group, which deals with nanooptics, is led by Rainer Hillenbrand from Germany.

Pitarke brings us more details:

–A lot of work is being done nowadays worldwide to develop optical nanodevices. To that end, you need to learn how to manipulate light at the nanoscale, and that is precisely what we are doing here. Andreas, Paolo, and Rainer are physicists, so for the third research group we looked for a chemist, as we wanted to be an interdisciplinary research center. We hired Alex Bittner from Germany, who is the self-assembly group leader.

Before we move forward, we should take a moment to look at the concept of interdisciplinarity. Etxenike emphasizes this aspect, as he thinks back to the time when the research groups were being put together.

–Txema was very clear about the criteria: first of all, our new hires had to trust us; secondly, we had to trust them; and, our third criterion was that we needed scientists with different backgrounds, simply because nanotechnology is interdisciplinary, transversal. In fact, in the nanoworld of atoms, chemistry, physics, and biology all come together, they all become the same thing. This is a very important idea. So we had to recruit physicists, chemists, and, eventually, people from biology.

Now, brackets closed, Pitarke goes on to explain how the research groups were put together:

–Group number four dealt with nanobiotechnology. At first, we brought a Lithuanian biophysicist from France; but we had trouble

with him, as he had kept his university position in France without us knowing he was still in France and without the French university knowing he was here with us. After two years, we had to fire him; it was a *fair dismissal*. Currently, the leader of that research group is Raul Perez-Jimenez. Group number five, the nanodevices group, is led by Luis Hueso and Felix Casanova; Felix would join us later. Those five research groups, with their respective group leaders, were set up in 2007-2008. At the opening, in January 2009, we had five group leaders plus Vavassori, who is the nanomagnetism group coleader. All in all, we had six senior scientists in place.

Cleanroom (2015).

The sixth research group was set up in answer to a need.

–At that point, we all wanted, and needed, an electron microscope. We had to buy one; but instead of just getting the tool, we thought we had to be bold and attract a top scientist working in the field. We hired a Russian researcher, Andrey Chuvilin, who, at that time, was at a German university, so we set up a new research laboratory on electron microscopy. Andrey is an excellent microscopist. After that, we wanted to focus on the opening of new research groups that would be more industry oriented, as we wanted our research to have an impact on industry. But group number seven was an exception: we brought in a theoretical physicist from Cambridge (UK), Emilio Artacho. Emilio is the theory group leader. For the eighth research group, we brought chemist Mato Knez, a Croatian who grew up in Germany. Mato is the leader of the nanomaterials research group. Mato's research has a direct impact on industry; as a matter of fact, one of nanoGUNE's spin-off companies emerged from that research group.

The creation of group number nine, the nanoimaging research group, was not straightforward.

–I thought it would be important to do scanning tunneling microscopy in a center like ours, as we work on nanoscience and nanotechnology. For that reason, in 2008 we opened a new position in order to create a research group on something connected with STM. Nacho Pascual applied; he is from Madrid, but at that time he was in Berlin. We made him an offer; but he did not accept it, as he had been made a very good offer in Berlin. We had interviewed two more candidates. They were both very good; in fact, upon my request, they applied to Ikerbasque, and Ikerbasque selected them to come to nanoGUNE. But finally we decided not to fill that position. Two years later, we invited Nacho to San Sebastian, to the DIPC10[38] conference, to give a talk. I showed him around nanoGUNE, he liked it, and sounded interested in joining us. We opened up again the position we had left vacant two years earlier, Nacho applied again, I

[38] DIPC10: conference organized by the DIPC to celebrate its 10th anniversary.

offered him the position, and he accepted this time. He is the leader of group number nine, the nanoimaging group.

–We are missing group number ten and its leader.

–Group number ten was created differently. In 2013, as soon as Arantxa Tapia took over the ministry of economic development and competitiveness of the Basque government, we were told that we would need to fulfill certain conditions in order to still be, after the year 2020, a Cooperative Research Center in the RVCTI[39], which the center needed to be in order to be able to operate. One of the conditions was that 30% of our income had to come from private funding. Later on, that 30% was lowered to 10%; but not as a target, which remains the same, but as a condition for continuing to be part of the RVCTI. By the year 2020, at least 10% of our income needed to come from the private sector.

–Was that an absolutely necessary condition?

–Yes, 10% is the minimum that we need to reach in order to be able to keep going. In order to get base funding from the Basque government, we need to be part of the RVCTI; and with no base funding, we would not be able to operate. That started in 2014. At that point, we decided to create a new research group dealing with industrial research, and that is group number ten, the nanoengineering group, which is led by Andreas Seifert, another German, and also another man.

INFLUENTIAL GERMANY

'A German and a man' has become a common line at nanoGUNE. In fact, that is precisely the main profile of nanoGUNE's group leaders. Etxenike came up with the line:

–All the group leaders at nanoGUNE are men; and, at the beginning, the members of the international advisory committee were all men, as well. Txema wanted to bring the best possible people, and I

[39] RVCTI: Red Vasca de Ciencia, Tecnología e Innovación - Basque Network of Science, Technology, and Innovation.

thought to myself: they are all men and German, each of them is the best, but the team might not be the best.

Pitarke picks up the baton:

–This is a delicate issue.

–Because they are German or because they are all male?

–Their being German is normal. The first three group leaders we hired were all German: Berger, Hillenbrand, and Bittner. That was no surprise for two reasons. First of all, because Germany is at the forefront of science in Europe. The UK too, because there is a tradition there, with a number of famous universities like Cambridge, Oxford, and others; but nowadays, in my opinion, Germany is at the forefront in science and technology, in particular in nanotechnology. There is no doubt that Germany is one of the top countries in this field.

–Are we talking about what before reunification was West Germany or East Germany?

–The whole of Germany. In terms of technology, it used to be the Western part; but in Eastern Europe and, more specifically, in the former Soviet Union, science education was particularly good. In research, when we come across something new, we often find some old paper written by somebody from the former Soviet Union that has passed us unnoticed. Maybe hardly anybody paid attention to it at the time; but the paper is there and we can find it now.

–The Iron Curtain was there in science too.

–Scientists from the former Soviet Union used to publish in their journals, and the Americans used to publish in american journals. Here we are all aware of the research that Americans have been publishing over the years, but we have paid less attention to journals from the former Soviet Union; they have been hidden from us in a sense. When Germany reunified there was a qualitative leap. Look at Humboldt University, for instance, which before the reunification was in East Berlin.

At this point, we have to get a German's point of view, so we turn to Andreas Berger, nanoGUNE's research director.

–The university standards are better balanced in Germany than in the UK or the USA; German universities are not so selective. In my field, for example, in the area of magnetism, I cannot understand why British scientists are better known here than German scientists, as the most complex contributions, the most advanced experiments are being carried out in Germany and not in the UK. It may be a question of rivalry with England, I don't know, but here people look to England in particular, and I don't know why. Besides, it's not just Germany: Switzerland and Holland have very good universities too, with great centers and top scientists; but people here tend to look more towards the UK.

HIRING THE VERY BEST

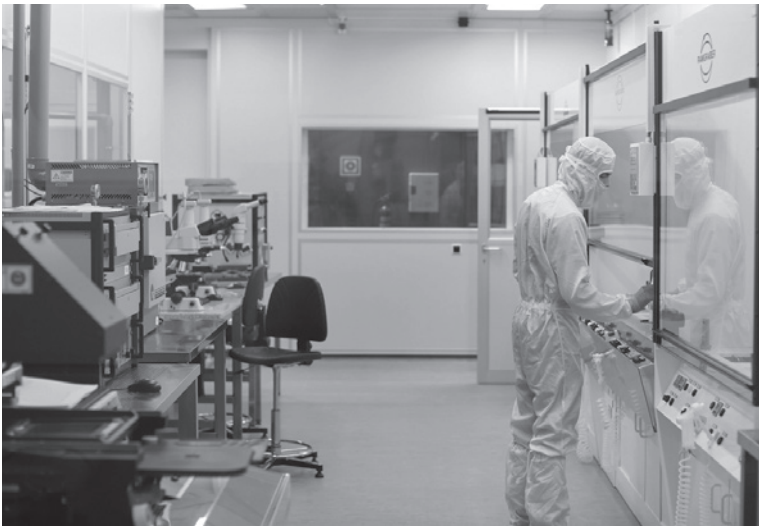
Europe's science map has been drawn. Pitarke says they look for the very best researchers, but what are nanoGUNE's criteria for the selection process?

–We always choose the very best people, but not necessarily those with the best absolute indicators. We always choose the candidates that have the greatest projection in a given field. We are concerned with the future of the center, so we look for promising candidates who will put our center in a position to lead nanoscience and nanotechnology in certain research fields. That is how it works at top universities and research centers in the US, for example. Here at the university there is a tendency, sometimes, to bring collaborators who would not eclipse our existing research activity. At nanoGUNE, however, we follow the American model. We look for merit, of course, but that is not enough in itself. Ours is not a simple merit-based selection process.

–Taking that into account, what type of indicators do you use and why?

–For example, the number of research papers in high-impact *peer-review* journals, and also the candidate's contribution to those papers. Papers can have a single author; but usually research papers are jointly authored, and the signing order should be taken into account. It is particularly important to look at the impact of a given paper on

the international community. We also look at the number of talks given at international conferences –which shows the degree of interest in the candidate's research among researchers worldwide– and at the candidate's track record of securing competitive funding. But most of all, our aim is always to attract candidates with the greatest potential for success, and that's precisely where we have to get it right!



Photolithography bay of the cleanroom.

–The criteria are clear now, so we come to the group-leader selection process. How does that work?

–We invite some of the candidates in a short list; two or three candidates per position, at most. I say invite because when it comes to the group-leader selection process we pay all the travel expenses. We start at nine in the morning. On their arrival, I explain nanoGUNE to the candidate: what it is, who we are, and what we do. This would not necessarily be a PowerPoint presentation: it could well be simply a conversation. We look at the candidate and the candidate looks at us. Pedro often says that when it comes to attracting top talent, rather than us choosing them, it's them choosing us.

–So it's a two-way interview.

–That's right. After the first meeting we normally visit the laboratories.Then, at eleven in the morning, the candidate gives a talk in our seminar room. The seminar talk is open to all nanoGUNE researchers and also to the whole scientific community around us. We usually announce the seminar at the University of the Basque Country and, in particular, at neighboring research centers such as the DIPC and the Materials Physics Center, both of which are on campus. It is a 45-minutes talk followed by a discussion of around 15 minutes. Then we do the interview. Our research director Andreas Berger and I interview the candidate for about an hour and a half: who they are, what they are, where they come from, what they would like to do here, what their weaknesses are, their strengths… The usual kind of interview for this type of thing. Then we go for lunch together. After lunch, we ask the candidate to give a second presentation, but this time only to Andreas and me, with their research plan, and also with an explanation about the scientific equipment and laboratory space that they would need for their research at nanoGUNE. The candidate then talks to our group leaders individually, not necessarily to all of them, more likely to the senior scientists who are working in related research areas. After all these meetings, the candidate comes to my office so we can have a general discussion about what they have seen and, in general, about anything that we might want to clarify. We finish at around six or seven in the evening.

–This sounds more like an endurance test!

–That is how we have been doing with the group-leader candidates so far. When it comes to the other members of the research team, the process is simpler.

–Has there ever been a group-leader vacancy?

–Only when we had to fire a group leader. NanoGUNE has always been very stable. We would like our twelve senior scientists to stay here forever, but all the other researchers (fellows, post-docs, and PhD students) have to leave after a few years at nanoGUNE: they are all in rotation. So far, none of our senior scientists has left. And that could

well happen, of course. That is to be expected. In fact, if they are good and have international recognition, they will be wanted elsewhere; otherwise, we would be doing something wrong. That risk will always be present: here, in Cambridge, or at MIT.

–Does this mean you need to increase the hiring price?

–It isn't so much about the price, that's not the only thing. We don't attract scientists with the salary; they have competitive salaries, of course, but they are no higher than in other places. Some of our group leaders have been offered professorships from a number of foreign universities, in Germany for example, but so far they have all stayed here.

–NanoGUNE has twelve senior scientists in total, all of them Ikerbasque research professors, with the exception of the research director.

–Ikerbasque is a foundation launched by the Basque government in 2007. What was it created for? To attract to the Basque Country excellent researchers from all over the world. These researchers are to be located at Basque universities or research centers such as nanoGUNE. Following a rigorous selection process, Ikerbasque has been able to attract a good number of world-class researchers, so Ikerbasque is a seal of guarantee for us. Nevertheless, our candidates need to also go through our own selection process, which is tailored to our needs. At the moment, there must be about 300 Ikerbasque researchers in total. Many are research professors; others are research associates and research fellows. At nanoGUNE, we have eleven research professors and also a few fellows in rotation.

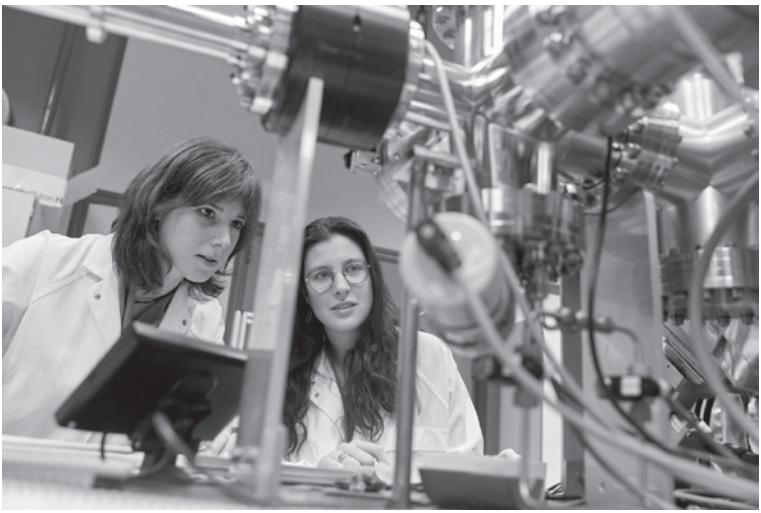
PUTTING THE RESEARCH GROUPS TOGETHER

–Each research group has its own field of activity and its own leader; but more researchers are needed in the group. How does that work?

–Once we hire the group leaders, we trust them implicitly; our guiding principle is trusting people. Our group leaders have freedom to do as they see fit in their research field, which is very important for creativity. In that context, group leaders can organize their research group as they please, so they choose their group members using the funding they have been able to secure, except at the very beginning when they are given a start-up package. That package usually includes two PhD students for a period of three to four years, and one post-doc for a period of two to three years. Once that is over, they have to secure their own funding. The size of the group depends on the ability of the group leader to attract external funding, and also on the type of research group they aim to build. Some group leaders don't want to have a large team. Neither do I: big teams are not necessarily more efficient. Disruptive research is known to be usually carried out by small teams. 'Large teams develop, and small teams disrupt science and technology' is the title of a paper recently published in *Nature*; I would agree with that. The optimal size of a well-balanced team depends, of course, on the type of research, but it is always true that effectiveness does not necessarily increase with team size.

–What is the optimal size?

–That depends on the type of research. At nanoGUNE, we have, on average, no more than ten people in each research group; that's a good average. Here I follow the American model: a group leader and their research team; not too large a team and in rotation. The German model, for example, is sometimes somewhat different, so as some of our group leaders here are coming from Germany, we occasionally disagree about that. The German model is often based on a big professor with a lot of power and with a number of researchers working with them, some of them maybe permanently, in large teams.



Deposition laboratory.

–How large are those teams?

–At the Max Planck, for example, there might be research groups of 30-40 people, even up to 50 or more sometimes. Big ones. Often, though not always, professors put their name on all the research papers in the group, on everything produced by the group members, which sometimes is not necessarily reasonable. It's good for the professor, of course; but it is usually hard, in research, to be in control of everything that is being done within a team of 20 people, and even harder when it comes to a team of 40-50 people. Large groups are typically hierarchical; there are sometimes a number of permanent researchers in the group, which is of course convenient for the professor, but is not always the best solution for research or for the research center.

SYNERGIES

Andreas Berger, nanoGUNE's research director, has played a key role in putting the ten research groups together, and he still plays a role in the overall management of the whole research team. He is also the leader of one of the groups, the nanomagnetism group:

–We are not ten independent groups, not at all. We need to work together, because a center like this only makes sense if there is good collaboration between the groups. In fact, that is precisely the advantage of a center like this: experts from various groups working together on a new problem can always go further than within a single group.

–Synergies between different groups?

–With no synergies between groups, being in the same building is not enough. We need a research team that works together; and that has worked very well so far, with no problems arising among the researchers. One researcher might not like a particular feature of a project, but that is to be expected. We work perfectly well together, which is often not the case at universities.

–What are your responsibilities as research director?

–At the beginning, once the research team was on board and the major equipment had been purchased, we had to define a collaboration strategy; and now that there are no longer 25 of us but 100, we need to carry on with our philosophy of teamwork and process efficiency. Now we have to control who has access to a particular piece of equipment, how long it can be used by a particular PhD student… In fact, all processes need to be well organized in order to ensure the overall functionality of the research tooling. Establishing priorities is now one of the things that takes longest. For example, I have to identify repairing priorities. We have an annual budget for repairs, and I have to decide, along with all the senior scientists, where the priorities are. We also need to anticipate in which areas we are working well, where we need more knowledge, what we need to consolidate… All of that is part of my job. We also aim to maintain research efficiency. Those are my two roles.

–Management work, to some extent.

–Yes, but my job is to lead the research. We need to reinforce our applied research; that is another of my responsibilities, which I share with Ainara Garcia, our TechTransfer manager. We have to look for opportunities that would work in both worlds: fundamental research and industry.

–You are also the nanomagnetism group leader. How do you combine that with being research director? Do not the other group leaders get jealous?

–No, that's working well. There are two things involved. For one thing, there is a coleader in my group, Paolo Vavassori; I am research director, but I am also directly involved in research, as a group leader, and having a coleader helps. Paolo makes things easier; we have known each other for many years; we work together and also independently in a number of research areas; that works out, and we get along very well. And then, as research director, I have other responsibilities. I am aware conflicts could arise; but there has been no trouble so far, because we work in a very transparent way: "This is for you, this is for me…" We have no problems because of me combining the two jobs. As research director, there is a great deal of administrative work that nobody likes doing, so the senior scientists are happy to see I take care of all that. I think they don't envy my job.

–Group leaders need to look for funding. Is that a burden for researchers? Could it be done differently?

–At private companies it could, but not at public centers. At large companies, such as Hitachi, everything is paid for by the company; but in centers like ours, all over the world, scientists have to seek funding from foundations, governments, and companies; that's how it works. It's very demanding; but that's how the system works, as the government only has funding for the most outstanding research. You have to request funds from the European Union, for example, and that is difficult because the success rate, depending on the call, may be no more than 2-3-4%. My latest funding proposals to the European Union were not selected for funding; I must have submitted 10 proposals over

7 years. Senior scientists usually submit between three to six funding applications every year. Once the funding is secured, you need to write the annual reports… It is a lot of work. Sometimes researchers, senior scientists in particular, spend a whole week writing proposals. If we work ten hours, nine of them are not spent generating new scientific ideas, younger researchers do that; senior scientists spend most of their time managing research projects and organizing things, so they have less time to produce new ideas. It's like that all around the world.

CATEGORIES AND ROTATION

Having arrived at this point, we should explain the classification of researchers in the world of science, along with the words that are usually used to define their status, words such as *fellow* and *tenure track*. Pitarke gives us some details.

–You've mentioned the idea of rotation. At nanoGUNE, group leaders have permanent positions, but all the others are in constant rotation.

–People here come and go all the time. New PhD students and post-docs are joining us constantly. Fellows do too: they stay here with us for three or five years, depending on the type of grant they have.

–What are fellows?

–This term is widely used in science. For example, I am a Visiting By-Fellow[40] in Cambridge; you could also be recognized as an Overseas Fellow[41]. Here, we use the word *fellow* with a different meaning. At Ikerbasque, the title Ikerbasque senior researcher was used at the beginning; then they switched to Ikerbasque research professor. *Professor* is a title that in other countries has a social connotation as well. Ikerbasque research professors have a permanent contract. Later

[40] Visiting By-Fellow: outstanding senior academics from overseas staying for relatively short periods of time, such as one term.

[41] Overseas Fellow: outstanding senior academics from overseas staying for at least two terms.

on, a new category was set up for younger researchers with a five-years temporary contract; these researchers were called Ikerbasque research fellows. These new positions were advertised as *tenure track*.

–What is *tenure track*?

–First of all, I'll tell you what *tenure* is. It is the right that university professors have in some countries not to lose their position without just cause. It is primarily intended to guarantee the right to academic freedom, the idea being that it is beneficial in the long run if professors are free to carry out their research without fear of dismissal from their jobs. This freedom means that creativity is not restricted by the evaluation criteria of superiors. Tenure contracts are often offered in the UK and the USA. A contract with an option to become tenure after a given period of time, usually after five to seven years, is called *tenure track*.

–Let's come back to the rotation idea; what is the timing, and how does it work?

–Researchers joining Ikerbasque with a five-years contract are called *Ikerbasque research fellow*s. We have had, and we still have, a few of them at nanoGUNE, but they're not on *tenure track* with us, as, in general, they have to leave us after five years, even if they have a positive evaluation. Ideally, they would stay somewhere else in the Basque Country, but not at nanoGUNE. Out of the seven *Ikerbasque research fellows* who have completed their five-years contract at nanoGUNE so far, four have joined other research centers or universities in the Basque Country, and the other three have been offered university positions back in their places of origin. None of the four fellows who remain in the Basque Country were born or raised here; they were all attracted to nanoGUNE from somewhere else. We've also had a few *Gipuzkoa fellows* for a period of three years; two of them have completed their terms here: one is now at the University of the Basque Country, and the other has joined one of our spin-off companies, Ctech-nano. We have had very good researchers. They had to leave nanoGUNE at some point, but new people will come. That's how rotation works.

–Is that the normal way of doing things at research centers?

–At the very best universities, in the US for example, things work like that; they would always say: "New people will come". Besides, researchers who have spent some time with us and are now in other parts of the world are ambassadors for our center and our research, which increases our international recognition.

–How old are the members of the research team?

–Our rule is that we need young people here. I never wanted to necessarily bring outstanding scientists with consolidated research careers. We've always looked for young people with great potential. Mind you, researchers in their forties are still thought of as young! Our goal has always been to attract young scientists with the potential to become international references in their fields while they are here with us. All our senior scientists are over forty; our *fellows* are between 35 and 45; post-docs are between 26 and 40; and PhD students range from 23 to 30 years old. PhD theses are usually finished at the age of about 26-30. We also have a number of *guest researchers* of all ages. There must be about twenty-five of them with us right now. Some guests come over for a week, others for a month, for three months… or for a year.

–So rotation does not go with the academic year.

–Not at all. I sign contracts all year round. Our finance director, Miguel Odriozola, comes to my office at least once a week for me to sign contracts. The members of the research groups are chosen by the group leaders.

–Do you advertise open positions?

–Every time a new position becomes available, we follow a well-defined procedure: the process has to be public, and it must be advertised in such a way that anybody can see it. Then the group leader chooses the candidate that best fits the job profile. Group leaders will have to justify their choice, but they make the final decision.

–Altogether, how many researchers have worked at nanoGUNE?

–Up to the end of 2019, 644: 253 of them were guest researchers, 140 were undergraduates and master students, and 251 were on the payroll as seniors, fellows, post-docs, or PhD students. Out of those 251 in the payroll, 43 finished their PhD thesis here at nanoGUNE. Where did they go? 28 went to academia –universities and research centers– to keep on doing research, 13 went to industry, and the remaining 2 went to teach at high school.

Finance director Miguel Odriozola gives us more details:

–About 35% of our personnel are permanent, while the remaining 65% are personnel in rotation. In 2019, about 50 new contracts were signed, four per month on average.

–By the way, what is nanoGUNE's economic structure?

–This is how it works. Since 2008, the Basque government has been funding a significant part of our non-economic activity through a non-competitive base-funding scheme. This funding covers a major part of the structural running costs of the center; it allows us to open the doors every day and have a secure minimum structure. Our ten research groups can operate thanks to this structural funding; but, at the same time, they are responsible for bringing in their own external funding, thus covering their ongoing-research and personnel expenses. The more public funds they rise, the more private funding we need to bring, as at least 10% of our total income should be private. The Basque government is not asking us to bring a minimum absolute amount of private funding; instead, we are expected to bring a minimum relative amount of private funding of 10%, the target being 30%. We need to reach a good balance.

SUSTAINABLE GROWTH

Continuously chasing research grants could become counterproductive if things were not kept in proportion. Etxenike has something to say on that:

–Pitarke is clear that nanoGUNE should not grow indefinitely, in the way universities do sometimes; as they have gone through so many precarious situations, they act like a dog with bone in hand that eats as much as possible out of fear that there will be no food at a later date. But here, at nanoGUNE, it has always been very clear, since the very beginning, that there is no need to grow too much. That happened, to an extent, to the technology centers. Growing too much entails spending a lifetime searching for grants to be able to maintain what you have created, instead of being doing what you should be doing. If too large a structure is built, so one needs to be constantly chasing projects in order to be able to support that structure, what we have done is transform projects, which are simply the means to reach our goals, into an end in themselves. NanoGUNE has always known how to target the right size and dimension in order to become a center of excellence, without growing and growing. Txema has got it right there too.

Pitarke has it under control.

–You don't want to go beyond ten research groups.

–Not in principle. I don't think that's necessary right now; but I do not want to close the door on that.

–And if a new research group were to be opened, in what field would that be?

–Bio, I think; we would probably strengthen our nanobio research area. I don't think we need to open a new research group now, but I have to say that a few good candidates have approached us recently.

–So potential candidates come your way.

–All the time, and usually we have to tell them no.

–You also cultivate more informal relations with the group leaders, beyond the rigors of work.

–Once a year we go away on a two-days retreat, all senior scientists and me, thirteen of us altogether. Last time, in 2019, our TechTransfer manager, Ainara Garcia, joined us as well. We stayed at Chiberta

Hotel[42] in Angelu. The first retreat was held in January 2010 at Iriarte Jauregia Hotel in Bidania; the second one took place in October 2011 at Jaizkibel Hotel in Hondarribia; and, since then, we have got together every year towards the beginning of October.

The retreat map crisscrosses the Basque Country from side to side. After Bidania and Hondarribia came Arantzazu, Getaria, Legutio, Larraine, Hondarribia again, then Mungia, Igantzi, and Angelu. That is where all the retreats have taken place, year after year. What is the plan for those?

–Brainstorming. Also, on the morning of the second day, we organize a leisure activity. At the beginning, we used to go for a hike. Some of us love hiking, but other people don't, so, for example, when we stayed at *Irri Sarri Land*, in Igantzi, Navarre, we went canopying.

Going on retreats brings us to Etxenike's style, the *savoir faire* so typical of his ecosystem. The DIPC founder summarizes it this way:

–The list of directors and former directors of the centers belonging to what is sometimes called the 'Etxenike ecosystem' is as follows: Andres Arnau, Javier Aizpurua, Daniel Sanchez-Portal, Ricardo Diez-Muiño, and Txema Pitarke. I gave them one single piece of advice: meet once a month for lunch, and talk about everything and anything. If there is a misunderstanding, do not try to fix it by email: get together, eat, and talk. And that has been working very well. I would not want to see them annoyed with each other; that was my great concern. These basic rules are based on my own experience.

[42] Chiberta Hotel: in this hotel, historical encounters took place in 1977 between Basque nationalist parties, promoted by Telesforo Monzon.

FIFTH CHAPTER
NANOPEOPLE

THE ROLE OF THE COFFEE MACHINE

To the left of nanoGUNE's spacious lobby there is a corner like a cafeteria, with stools and high tables. The DIPC has a gathering point too. Maria Rezola explains the reason:

–In the US, Cambridge, and other such places it must be usual for people to gather around the coffee machine to share ideas, to generate that team feeling; that's why those little tables are there. There is the name too: *Interaction Area*.

A bunch of people or just a few, there is always somebody there, all gathered around the smell of coffee. NanoGUNE is open 24/7, which means anybody can be there any day at any time working at some laboratory. Scientists are not mean with their time, they always spend all the time they need for their research, even though it sometimes might seem to be in vain. At nanoGUNE, there are people from all sorts of countries; at the end of 2019, there were researchers from 26 different countries all over the world. The *lingua franca* is English. The governance of this diverse community requires pulling a lot of threads, and yet nanoGUNE is not a place bogged down by bureaucracy; the operation of the center is fast and agile.

NanoGUNE's interaction area, by the lobby.

Some of the nanopeople work at administration and services, and others are technicians; but most of them are scientists. What are scientists like, what is their profile, what sort of lives do they lead? We asked Andreas Berger for some clues; in fact, as nanoGUNE's research director, he is fully immersed in that atmosphere, and, besides, he is a researcher himself with a long, productive career.

Berger is from Northwest Germany, the German industrial heartland of the Ruhr valley. He was born in Duisburg in 1964, he studied physics at the university there, and completed his PhD at Aachen University. He then pursued his scientific career in the US, first at the University of California, next at Argonne National Laboratory in Chicago, and finally at IBM and Hitachi, before joining nanoGUNE.

–Did you have a vocation for physics?

–After high school, I spent a year in the army, doing military service and trying to figure out what to do next. I was good at physics, chemistry, and mathematics. I also liked history and language, but at the end I chose physics.

–And when did you realize you could be a researcher?

– Probably in the fourth year, as it was a five-years degree. During the fourth and fifth years, I had to work on my bachelor thesis; I did a one-year project, and I liked it. Then I looked into doing a PhD. At that time, in 1989, it was not easy: as a lot of people had a physics degree, there weren't many PhD openings available. But I found a good opportunity at a major research center in Aachen and, after three years, I got my PhD there.

–Then you went to the US. Why there?

–My plan was to work in the US for a couple of years, because to build a research career in Germany it is important to have worked there for a few years.

–Research is rather new here.

–There are countries with a longer tradition. We have it in Germany, they have it in England too; but people in Germany do not know

scientists either, maybe Einstein, not many more. That is because in the world of science things move very slowly, as in the world of writers. Science is not about replying in six seconds someone's tweet; our world is not like that, and being a writer or a scientist is similar in that respect. We are not good at reacting quickly to rumors and things like that. Most people don't have time for writers or scientists; some do, but a large part of our society lives in a different world, doesn't it?

–Do you feel isolated?

–That isn't the issue. People sometimes speculate, thinking that something completely new is going to be invented in computing, for example. But science is something different: thousands of individual efforts have been made to get here. There are sometimes great discoveries; but most scientific work goes step by step. People often say: "That's a huge step forward!". But it isn't: it's limited. I don't like people talking about science that way, because it doesn't reflect reality. Science develops through the accumulation of many small steps, each of them requiring a great deal of work. That pace is not in step with today's fast world.

–So you are saying that science requires extraordinary patience and perseverance?

–Patience, perseverance, and lots of reflection. When I carry out further experiments to be sure, sometimes the outcome of the experiment tells me I'm on the wrong path. That's why our work goes so slowly, because there can be many explanations for everything. You have to repeat, change, and make sure the original explanation is correct; you have to make predictions and then experiments to check whether those predictions are correct. Often they are not. And then you need to start again. It's interesting, but it doesn't work for everybody. I see it often with undergraduates; the idea is for them to see how we work, how interesting it is, and they end up discovering how frustrating things can be. Often, some very good students don't react well to frustration, and then I say to them: "If you want to do research, you need to be able to live with frustration".

Nanopeople (2012).

–So patience, perseverance, and the ability to withstand frustration. Anything else?

–But that doesn't apply only to science: other jobs also require being able to withstand frustration. Sometimes when a paper is not accepted for publication in a given journal, PhD students get frustrated: "We've been working on this for almost a year, and now the editors don't want to publish the paper". And then I tell them: "And so, what? It's Friday today, you'll still have a job here on Monday, me too; when you work in sales, if clients don't buy enough you won't have a job the following month. So, things could go wrong for us, but not as wrong as for other professionals". In science, you need to coexist with frustration.

–You've drawn a parallel between scientists and writers. What is the connection?

–In both cases, a creative process is at the core. One is creating new knowledge, new forms of expression, and both processes are complicated, they both take time. In science, you need to confirm the experiments and you confirm your ideas when you write. It's very similar. In this fast-running world, in which a new story is created every minute, these two disciplines are not very attractive, especially for young people who need something new every single minute. It's

very hard for me to persuade my daughter to read a book, to read a complex story with a lot of different characters, a lot of plots, different ideas... There you have an opportunity to think about your life, about the entire world. But people don't spend time on that, simply because they have other things on their mind, because they –young people in particular– are addicted to getting a new story, a new photo every minute. It's a pity they have no room for deeper things which take more time to be understood and to be explored. I think this issue applies to both literature and science.

–You seem to like literature.

–Yes, I do.

–What do you read?

–All sorts of things. I read in English around 60% of the time, and the rest in German. Right now, I'm reading a new biography of Winston Churchill.

THE COUNTER PLANE

Itziar Otegui (San Sebastian, 1984) has been nanoGUNE's outreach manager since September 2012. She is in charge of informing society about the center and its research activity. That requires close contact with all the researchers.

–What do you think of scientists?

–Most of them are very normal people like you and me: they wake up in the morning and have a hard time getting to work… Then they work with great passion. I think it must be very difficult to make your way in science without passion. You do something, and if it doesn't work you need to try something else; then you need to check the result, you get frustrated again, start all over again. And so on, over and over again, until it works out. With no passion, they would collapse in a heap. As they are normal people, some days they work with more passion, and other days they fall apart. They're smart people, no doubt about that; some of them are exceptionally smart.

They are curious about many things: politics, culture, economics, climate change, pollution, welfare society… everything concerning humanity. I've met people with great hunger for knowledge, well trained, informed people with ideas of their own and a critical mind. They need to understand everything, always questioning things, and skepticism is rampant among most of them too.

–They must be psychologically strong, as they keep failing and then trying again.

–Yes, and they have disappointments here and there; but they get up and start over again.

Maria Rezola has had a direct relationship with scientists, especially during nanoGUNE's early days, as the center was being built. She has a first-class observatory at the coffee machine.

–Groups of people gather together around the coffee machine; they drink coffee and go forever talking about things. You can see how serious and thoughtful they are all. I don't think they really separate their personal and professional lives. We do our eight hours and, after that, we go home and have our own world. I think scientists often take this world home, and they do that after spending many hours here at the center.

–How many hours is that?

–I don't know; but when you go home there are still people here. If they're doing something in the lab, a test or some analysis, that takes time. They go down to check the sample, and two hours later once again; they are tied to the lab. When they write papers, they do it together; you see people in a meeting late Friday afternoon, talking to each other in great earnest. If you walk past here over the weekend, and the lights are on, it's because people are working here. It's a matter of mentality too...

–Does that depend on where they come from?

–There are many Chinese and Russian people; they have a different way of doing things, of course. Maybe they do their weekly hours and don't come over the weekend; but, as I said before, some of them

are here on Saturday and Sunday, and you wonder: "Do these people ever disconnect… or maybe they only live for this?". First of all, they leave their country to come here. For example, Andreas Berger came from the US with his family, and there are many like him: they come over, bring their families and their children to a new country, a new language… Their work is extremely important to them; it has a real impact on their personal life. I think researchers' personal lives are very much determined by their job.

Nanomaterials laboratory.

–The *cliché* about scientists being absent-minded and so on, is there any truth in that?

–I think so. Not all of them, though! They're not all like Einstein, but we have had a few of those. You see them going down the corridor deep in their thoughts. Sometimes you're surprised: they're so smart, but they sometimes get confused by the simplest possible administrative procedures. They live in their own world of atoms, particles, and energies.

–They make simple things difficult?

–They often question things, all sorts of things. Often they don't seem to get simple jokes. Then there are cultural differences too. Russians, for example, are sometimes colder, more closed-in.

–What about Chinese people?

–People from some nationalities form their own groups; they might mingle with the others, but the Chinese, for example, all meet up at 12:30 to go up for lunch together. And the Russians too, they all go together. Now, we have quite a few South Americans, and they too form a group. After all, people seek the support of their community, their language, their mores, their things.

–Do the Germans also form a community?

–To a certain extent. I think they are used to traveling, to working in Europe; you do see Germans together, but perhaps they don't need a community so much, they are more individual. Their mores and habits are not so different from those here in the Basque Country, unlike the Chinese, the Russians, or the Indians.

–What about the Indians?

–The Indians, on the one hand, are very modern, as they go all over the world and work everywhere; but they keep their cultural mores.

–How do these *united nations* get together?

–The younger ones go on pintxo-pote[43], they go out for dinner, to cider houses… Often they don't have anybody here, and, at the end, their nanoGUNE colleagues become their family. Here, once a year, we host the *International Lunch*: everybody brings some typical food from their own country, they explain what it is, and that is another way of meeting and getting to know each other.

[43] Pintxo-pote: deeply rooted activity in today's Basque society; it consists of going out to bars to have a *pintxo* and a drink at a cheaper price than usual; it usually takes place on Thursday evenings.

–What do they know about the Basque Country?

–People who come from far away don't know a lot; but the Germans, for example, do. At nanoGUNE, they are offered Basque and Spanish lessons for free. Most of them take Spanish, but some of them learn Basque. I think that, in general, they have pretty good lifestyles here. They always say they feel very integrated. Those who go to northern countries afterwards notice the difference: "Life was so good in San Sebastian!".

24/7

NanoGUNE's finance director, Miguel Odriozola, takes care of the work contracts, the payroll, and all administrative work related to human resources; he is responsible for the people management process. In that area, particular attention is paid to the Welcome Plan.

–Some people need to have everything explained to them; they don't know, for example, how the health system works here. So you need to sit down with them and explain everything: health assistance, the tax system, and all the paperwork involved. If they come from abroad, they have to go to the police to get their NIE[44], they have to register at the city hall, they have to open a bank account... We have a Welcome Plan with all kinds of details about what they need to do, so their landing here is as smooth as possible.

–How about housing, how does that work?

–We do not actively provide housing, but researchers coming to San Sebastian can choose to go to the Talent House[45] for a given period of time. The Talent House is a building on Duke de Baena Street, at the site of the former Rozanes Mansion, a wonderful spot. The Talent House contains a number of apartments and is managed by the City Council; researchers can stay there for up to one year. It is organized

[44] NIE: Número de Identidad de Extranjero/a - Foreigner's Identity Number.

[45] Talent House: Etxenike's original idea, which was taken on by the City Council; the opening took place in 2011, while socialist mayor Odon Elorza was in office; there is a quote on the wall, written by Etxenike, about the cultural, economic, and aesthetic value of science.

as an aparthotel. There are small apartments and also medium-size apartments for families, so it is a good option while living in San Sebastian. Priority is given to post-docs, fellows, and senior researchers, but PhD students are also welcome as long as there are studios or apartments available. The place is usually fully booked, especially in summertime. It is a good way to settle down in San Sebastian.

–How does nanoGUNE compare to the companies where you worked before?

–Something that is crucial here is the fact that the parameters governing research are so different from those in private companies. I'm talking about parameters regarding the use of resources; for example, the use of time. You come on a Saturday, or you come at night, or you come at any time where people would normally be doing other things, and you will find people working here. They are probably researchers doing experiments, writing a paper, or something like that. I have always been told that research is something that, when it comes down to it, you do for yourself. When PhD students work on their theses, they are building their career; and the same is true for post-docs, they are building their careers too, as once they finish here they will need to continue somewhere else. So, in this kind of life, the time spent at work is not valued as in a private company.

–Hours are not recorded here.

–Well, you know that clocking in and out is now compulsory at all companies; that is the law. However, this is not easy for us, as you need to clock in and out even when going on a business trip. How many hours should we record on a business trip? When does work start, and when does it finish? We have to do something, but it's not going to be easy; in research, clocking in and out goes against your instinct, as here we seek the opposite: absolute freedom. We close the door to avoid being robbed; otherwise, the door would be open 24 hours a day.

–Does everybody have a key to get to the building?

–Yes. The reception is open from 8:00 to 13:00 and from 14:00 to 17:00; outside those times, the door is locked. When the reception

is closed, employees and guests can use their keys to come in at any time: morning, noon, and night.

–So the building is working all the time?

–The building is prepared for people to be able to come in at any time. We have a security system in the labs, as it might be risky to work in some laboratories alone; so there is a dead-person system with cameras reducing that risk. The building is operative twenty-four hours seven days a week, 24/7. There are also many foreigners at nanoGUNE with no family here; and they are young, so they have greater availability and can spend a great deal of time on their work, staying here long hours. The difference between researchers and other professional people is their use of time. In a company, in the framework of a project, you clock in and out and keep track of the hours you spend in the project, which provides information about the real cost of that project and whether it is losing money. However, it's not easy for us here to work that way, because in research you normally spend more than eight hours a day at work. In fact, you spend all the hours that you need to make progress with your ongoing research. In research, people are used to work that way, to spending all the time that is needed.

The research director, Andreas Berger, expresses concern about the laboratories being permanently open.

–It can be dangerous sometimes. I often talk to the researchers, not to the senior scientists, they don't go so often to the lab, but to the juniors. I tell them that they shouldn't work alone during the weekend because it is dangerous. If you go to nanoGUNE to write a paper or to read, that should be all right; but if you go to the lab during the weekend, you shouldn't be alone, there should be at least two people there. So far, luckily enough, we've only had one minor incident: somebody wearing sandals had a problem with the skin on the feet. In the labs, people should not wear sandals; but sometimes people don't take care of their own safety.

Pitarke explains the reasons why researchers spend so much time at work.

–In general, researchers do not necessarily work on the basis of what the research center or university is expecting from us or because we are being asked to do this or that. Researchers work simply out of curiosity and seek recognition from the scientific community. In a company, the boss will tell you what to do; here, at nanoGUNE, group leaders simply guide the kind of research to be done by their group members. And group leaders don't necessarily work because they want nanoGUNE to be an excellent center. There is something of that, of course, but that's probably not the main motivation. Researchers work for them, like piano players, writers, or any other artist. There is an international scientific community, and researchers always want to build their reputation up within that community. We all want to be at the top, at the frontiers of knowledge, and that means working really hard, sometimes as much as ten or twelve hours a day.

–That's why you trust them.

–Precisely. It is the same with the theses. PhD theses are for their authors; for the center too, but mostly for the PhD candidate. I am exaggerating a little; this would be the idealized researcher, who is simply seeking to go beyond the frontiers of knowledge. In the morning, sometimes, from the very minute we get up from bed, all we have in our mind is: "How can I deal with this problem? How should I carry out this experiment? How am I going to solve that dilemma? In order to find out, I'll go back to work after dinner, simply because I need to see the result of an experiment or a calculation, because I'm dying to know the outcome". Not every day is like that, of course; but that is often how researchers behave. Niels Bohr, for example, while studying the structure of the atom, used to say that he was working day and night. Bohr did not seek to discover the structure of the atom because that is what the university expected him to do; he was working morning, noon, and night simply because he was determined to understand what nobody else in the world was able to understand at the time! He had his ongoing research before him at all times! A few years later, when the young physicist Carl Friedrich von Weizsäcker had the chance to visit Bohr, he wrote, in his diary,

the following about Bohr in German[46]: "*Er leidet am Denken*", which means: "He is suffering from thinking!". It was his destiny not to be able to stop thinking.

–Can such a tension be kept up indefinitely?

–That is precisely why we need young researchers. And you know something else? Cutting-edge research can only be done with a high dose of creativity. This is crucial! If everything is too highly guided, our contribution will never be of the kind that brings real progress; if everything is too highly focused, we will miss many opportunities along the way. This is what the history of science has taught us over and over again. The most important scientific and technological breakthroughs have always come about through fundamental research not oriented to specific applications. Market-driven applied research also needs to be done, of course, but without neglecting fundamental research.

–That makes me think of literature.

–You're right. In research, over and over again, we find what we are not looking for, and those are usually the most important, disruptive achievements. As in literature, freedom and creativity are essential; they are both needed in order to be able to reach and overcome the frontiers of science.

GOVERNANCE

–Can you explain nanoGUNE's structure and functioning?

–With regard to structure, our internal relationships may seem a bit chaotic. This is not a standard company: in a regular company, everything is well structured; there is a general manager, the management team, and they will all spend their time in meetings. I don't want many meetings. Every week we have a meeting with all senior scientists, which is an hour long, no more than that. Andreas organizes it; if he's not around, sometimes I call it. Our researchers

[46] *Wahrnehmung der Neuzeit* (Carl Hanser Verlag, 1985).

here go to conferences and give seminars at other research centers and universities all the time, so our weekly meetings are rarely fully attended. Our yearly retreat, however, is always fully attended, as we all have to be there. The weekly meetings should represent an opportunity for new things to come out and to share ongoing research; these meetings and the annual retreat should be forums for strategic discussions. On the other hand, as requested by the Basque government, now we must have a certified innovation management system that follows the UNE 166002:2014 Standard[47].

–Who gives that certification?

–AENOR[48] or a similar type of company; certified certifiers. Our innovation management system was certified towards the end of 2017 by SGS. The system is useful for a few things. Within it, we have created a new structure which we call UGIDi[49], a unit to manage research, development, and innovation. I have my own way of doing things. As I talk to everybody, I am aware of everything; but I must admit there may have been a certain lack of coordination; people usually like to know what other people are doing. With this new unit, we have dealt, to an extent, with that possible lack of coordination.

–So it's about knowing what other people are doing.

–It's about knowing how things are going in general. Some people appreciate that. The UGIDi has eigth members, three directors and five managers: finance director Miguel Odriozola, research director Andreas Berger, and me; our TechTransfer manager Ainara Garcia, our facilities manager Gorka Arregui, outreach manager Itziar Otegui, projects manager Yurdana Castelruiz, and our external-services manager Gorka Pazos. We meet three or four times a year. This is the new structure we have set up in the framework of our certified

[47] UNE: Una Norma Española – A Spanish Norm.
[48] AENOR: Asociación Española de Normalización y Certificación – Spanish Normalization and Certification Association.
[49] UGIDi: Unidad de Gestión de la I+D+i – R&D&I Management Unit.

innovation management system. It's useful sometimes, although our operation is a bit special.

–In what sense?

–We always seek agreement; but if there isn't unanimity, there is no vote. It's the same in Cambridge or Harvard. That's how things work in research. A research center's orientation is not put to the vote. The next research topic for a given group is not voted on either; that, in principle, is for the group leader to decide. Agreement is sought, of course; but the strategy must be dealt with…

–Dealt with by whom?

–By the board of partners and the director. The director must listen; and if things are not properly done, another director should be appointed. And that, the appointment of the director, is dealt with by the partners of the center, who are, after all, the center's owners. Otherwise, there might be conflicts of interest and things could get complicated.

–Whose interests?

–People's interests.

–Conflicts of interest among the researchers?

–That could happen. For that reason, among other things, strategy should not be voted on. That is how things work at top research centers and universities worldwide.

–When you talk about conflict of interest, are you thinking of different fields, or are we talking about conflicts at a personal level?

–Researchers all have their own interests; that's to be expected, but strategy must be above all that. Strategy must contain the master lines. Of course, you have to listen to what people say and think, no doubt about that. All opinions need to be taken into account, and debate must be encouraged, that is where diversity of ideas comes from; but the final decision must be taken by the director. Are we going to vote on whether to buy an electron microscope or an evaporator? There will be a debate, of course, but not a vote.

–So voting is not feasible?

–Tell me what you need, and let's talk about it. With that information to hand, we put together an equipment wish list every year, and then we make a decision. Who decides? Andreas Berger and me. Andreas makes me a proposal, after having discussed it with all the senior scientists, and then I make the final decision on the basis of budget availability. I normally follow Andreas' recommendation, as he is the one who knows best.

–And who are you accountable to?

–This is a non-profit association. The partners are the DIPC, the University of the Basque Country, the regional government of Gipuzkoa, and three companies: CAF, Petronor, and Ikor. We have the board of partners and also a board of trustees with one representative from each partner. In our case, the board of partners and the board of trustees are one and the same. The board of partners has to pass the budget. We hold two annual meetings: one, before the end of the year, to approve the budget for the following year, and the other one, in June, to approve the accounts from the previous year. I give a general update as well.

–So you go beyond the accounts.

–Sure, I give an update on everything: recent progress and highlights. The partners are organizations and companies, and one of the partners acts as president of the association. Until recently, the presidency was in the hands of the DIPC, and our president was Pedro Etxenike as he was the DIPC's representative. In February 2019, a new president was appointed. Now CAF is in charge of the presidency, so our new president is CAF's representative, Javier Martinez-Ojinaga, originally from Bermeo. He is an excellent president.

–So there are no complaints.

–No complaints so far. We have a rather special structure, as the true promoter and owner of the center, the Basque government, is not a partner.

–Here the partners are not shareholders?

–Not really. At first, the initial capital contribution of each partner was of 600 euros, and they would then put up 6 000 euros every year. Later on, those fees went down a little bit. That's all. On paper, the partners are the owners of the center; but, in practice, objectives are set by the Basque government. The Basque government is not on the board of trustees, but we always invite two representatives from the Basque government: the director of technology and strategy, and the vice-minister of universities and research. So, formally, I report to the board of partners and to the board of trustees; but, in practice, I'm accountable to the Basque government and, more specifically, to the director of technology and strategy. Since Arantxa Tapia took over the then ministry of economic development and competitiveness, everything is highly structured. We go every year through an evaluation, which is mainly quantitative: how many publications, how much external funding, and so on. That's where we report on the center's progress.

FINANCE

The Finance director, Miguel Odriozola, outlines nanoGUNE's economic structure:

–About 50% of our income comes from the Basque government, specifically from the department of economic development and infrastructure[50], in the framework of various programs. The most important one is *Emaitek*, a program designed to provide base funding for technology centers and cooperative research centers. Then there is also the Elkartek research program. In the framework of these two programs, we get about 50% of our budget. European grants account for about 15%; another 15% comes from the Spanish ministry of science and innovation; about 10% comes from private sources; 5% is from the regional government of Gipuzkoa; and a small amount comes

[50] Since September 2020, department of economic development, sustainability, and the environment.

from the department of education and the department of health of the Basque government. In addition to that, the Ikerbasque Foundation pays for a large part of the salaries of our Ikerbasque researchers.

Pitarke gives more details:

–In 2019, our total income was 7.4 million euros. The Basque government's department of economic development and infrastructure contributed 3 million euros through the Emaitek program; this together with the funding we received through the Elkartek program made up about half of our total income. And about one more million euros came, in addition to the 7.4 million euros that we managed, from the Ikerbasque foundation to cover a major part of our Ikerbasque salaries. Beyond that, we receive very little funding from the department of education, as inexplicably our Ikerbasque research professors do not have access to the programs that this department manages to fund competitive basic and applied research. Why not? Simply because cooperative research centers are associated with the department of economic development and infrastructure, not the department of education; CICs, however, should be taken as a commitment of the whole Basque government! We also get some funding from the Basque government's department of health and from the regional government of Gipuzkoa. The remaining income, almost half of the total budget, comes mainly from Spanish and European competitive programs, and also in the framework of contract research with private companies.

–What do those 7.4 million euros pay for?

–Roughly half of it goes towards paying salaries; the other half goes to running costs. If we were to divide the total budget among all the personnel here, the actual cost per person would be double the cost of salaries. Let's say we hire a researcher: in order for that researcher to work here, we need a building, we need to open the doors every day, we need somebody at the reception, we need a projects manager, computers, we need to turn the light on.… These are indirect costs, overheads, which add up to more than our direct costs.

–After all, you depend on the Basque government, don't you?

–And we are very grateful from the support we have always received, particularly from the Basque government.

–What do they ask you for?

–At the beginning, it was not so structured; but now it is. In 2015, the Basque government issued a decree with various blocks. The first block establishes the kind of research we are expected to do: 60% of our income is to be used to carry out fundamental research, 30% for industrial research, and 10% to cover experimental development. As for fundamental research, we are expected to publish papers at high-impact international journals; as a result of our industrial research, we are expected to submit and license patents; and our experimental-development activity should lead to the creation of new spin-off companies and also to the opening of new business lines in local companies. It's not easy to quantify how much of our activity is fundamental research, industrial research, or experimental development; but we manage to do it somehow. We label all our funding sources, in that way establishing what kind of research we do each time. In 2014, I submitted a letter with notes on the draft of the decree...

Pitarke goes to his computer to look for the letter, which he finds quickly. His views on the relationship between fundamental research and industry are set out in another document, the speech he gave on nanoGUNE's 10th anniversary, on January 30th 2019:

"We are convinced we must remain committed to combining fundamental research –the kind of research whose applications are still unknown– with specific industrial-research and experimental-development activities focused on exploiting at any time the opportunities that can be found along the way (…) We should build on that. At the highest level. But in order to stay there, in order to be consistent, if we do not want to miss the boat, we need to keep doing the kind of cutting-edge research that would take us into uncharted territories, while still responding at all times to our commitment to industry: the industry of the present and the industry of the future. This is the big challenge of the small".

SIXTH CHAPTER
THE COMPANIES

GRAPHENEA, BORN BY SURPRISE

Six companies have been set up at nanoGUNE, in this order: Graphenea, Simune, Ctech-nano, Evolgene, Prospero, and BioTech Foods. The last one has attracted the greatest media coverage, as it deals with the production of cultured meat, which people find intriguing. However, taken individually, they all awaken curiosity, starting from Graphenea and its graphene production, and make you feel a sort of vertigo coming from the nanoscale.

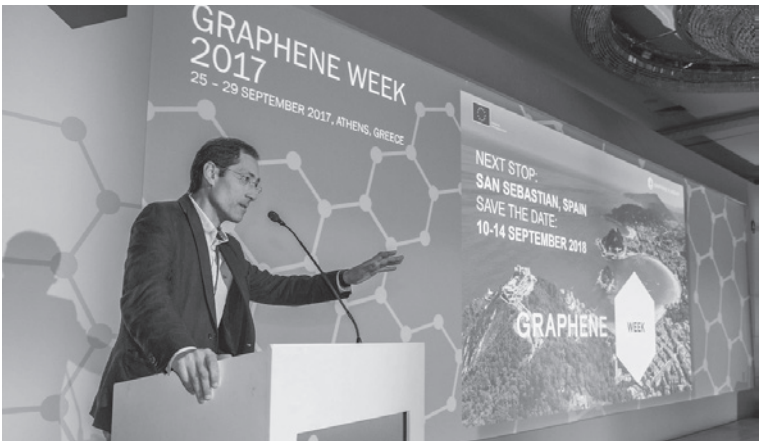
Sometimes, what these companies do sounds like science fiction. For example, Evolgene's mission is to recover enzymes that existed thousands of millions of years ago. In fact, we are talking about the threshold of the industry of the future. The main feature of all the companies set up at nanoGUNE is their ability to innovate, to work in fields that had not been developed here before, and to be recognized internationally.

They have all been, and still are, audacious projects arisen from the big challenge of the small. They have all had to face uncertainty, exploring unknown territories without fear of making mistakes or changing direction, starting with just the company name in some cases. Txema Pitarke tells us how he came up with the name of nanoGUNE's first start-up company, Graphenea, which is a word-play on the Basque suffix *-enea*[51].

–I made up the name using the Basque suffix *-enea*, combining English and Basque in one word. First I came up with Graphenek, but Andreas Berger warned me that Grafeneck[52] had been the name of a concentration camp during the Third Reich. So I discarded that name immediately; and after a little more thought, I came up with Graphenea.

[51] *Enea*: Basque suffix, which means belonging and is typically used for house names by adding it to a surname or a profession; for example, *Ajuriaenea* means Ajuria's house.

[52] Grafeneck: castle in the village of Gomadingen, south of Stuttgart.



Pitarke at the Graphene Week in Athens (2017)

Etxenike liked the name very much, because of the *-enea* suffix:

–It reminded me of Gaistenea, the name of my father's family home in Irurita.

Graphenea, nanoGUNE's first start-up company, set the bar very high: it handles 30% of the worldwide quota in the commercialization of graphene to be used for electronics for example. Companies of the caliber of Nokia and Philips are among Graphenea's clients. It may sound somewhat banal to say that it was chance that led nanoGUNE to found a company producing and selling graphene; but there was, in fact, an element of chance. Be that as it may, in order to make that chance possible, several factors had to fall into place very early on after nanoGUNE was set up. Txema Pitarke explains these factors.

–Graphene was discovered in 2004. When nanoGUNE was born, in 2006, we never thought we would set up a company to market graphene. The idea never crossed our minds; but, in 2005, in the report I sent to Jauregizar for the launching of nanoGUNE, I wrote an explicit proposal to open a research line on two-dimensional materials such as graphene. So as our objectives were broad enough, and we were able to attract top scientists in the field of two-dimensional materials, later on, in 2009, when we had the opportunity to launch a company for producing and selling graphene, we were perfectly positioned, as

we had the right knowledge and infrastructure to become competitive in the field. We were well prepared for the challenge.

The proposal was put forward by Jesus de la Fuente in June 2009. He was a consultant at PricewaterhouseCoopers[53] in Bilbao.

–Jesus used to explore markets and trends, that sort of things. He noticed graphene was an emerging field, so he wanted to invest there. He came to nanoGUNE and said to us: "There are four of us, and we'd like to invest 400 000 euros in graphene. Can you make graphene?". I had a meeting with Andreas Berger and Luis Hueso in my office; Igor Campillo was there as well. We gave some thought to the matter, and we realized that we had everything that was needed to become competitive. Furthermore, we realized it was the right moment to undertake something like that. Back then, there was nowhere in the world a suitable method to produce graphene at industrial scale, and, with our knowledge and infrastructure, we were convinced that we could be competitive. In 2004, Geim and Novoselov had managed to isolate, one by one, the layers forming graphite, by using a very simple tool: Scotch tape. Each of those layers is what we call graphene; and with that graphene they were able to fabricate devices and, given the importance of the discovery, they were awarded the 2010 Physics Nobel prize 'for groundbreaking experiments regarding the two-dimensional material graphene'. In one milimiter of graphite, there are around three million graphene sheets.

–That is astonishing!

–But, of course, the Scotch-tape method would not work for the mass production of graphene: the samples you get are too small and expensive. Geim himself said in 2009 that new methods had to be developed for the production of high-quality graphene wafers in order to take graphene to the market. We had the know-how, the knowledge; we also had the infrastructure, the scientific equipment, the laboratories. In addition to that, we had international contacts;

[53] PricewaterhouseCoopers: one of the four largest consulting companies in the world.

we were well connected in that world. We knew where to look, in what direction. In short, we were perfectly positioned and very well prepared. Jesus de la Fuente and I met a few times, and in less than one month after our first meeting in June 2009 we agreed on a route map. I went straight to London to meet John Pendry at Imperial College and John Pethica at the National Physics Laboratory –he was NPL's director at the time–, in order to ask them for advice; they were both members of our international advisory committee. I also asked for advice to Jose Maiz from Intel, also a member of our advisory committee, and I got in touch with the director of BIC Gipuzkoa, Marisa Arriola. Marisa helped me a lot. It all happened between June and July 2009. That very June, a research team in Texas published a very important paper in *Science*[54], demonstrating, for the first time, the possibility of producing large and reproducible graphene samples by using a method known as chemical vapor deposition (CVD). That was precisely what we needed. At that time, we were not sure about the method to use: the alternative was to grow epitaxial graphene on silicon carbide; but in view of this work, we opted for CVD, and that was the right decision. By using this method, graphene is not obtained from graphite but from vapor-phase molecules containing carbon atoms. Carbon atoms are placed one by one on a given substrate. The vapor-phase molecules are typically hydrocarbons (methane for example), and the substrate is usually a metal, the best one being copper. In order to produce graphene, what we do is put the whole setup in an oven at a very high temperature, about one thousand degrees Celsius. The methane molecules break down, and the carbon atoms that are left behind are then free to spontaneously form graphene on the metal surface.

–Do they sit there spontaneously, on their own?

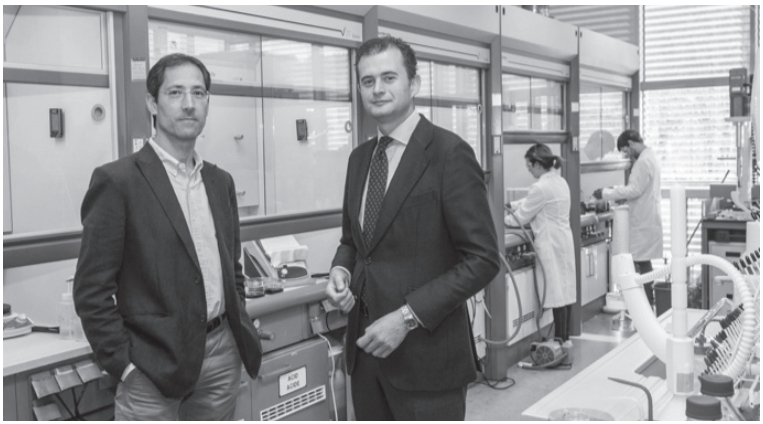
–Exactly. They sit there very nicely, all by themselves, forming a hexagonal honeycomb structure. That is graphene. Why do carbon atoms self-organize like that? Because that is precisely the configuration

[54] X. Li *et al.*, *Large-area synthesis of high-quality and uniform graphene films on copper foils*, Science **324**, 1312 (2009).

that minimizes the energy. You see, physical systems always seek to have as little energy as possible.

–So physical systems promote sustainability in a sense?

–Nature is wise.



Pitarke and Jesus de la Fuente, the day Graphenea started to fly solo (2015).

THE APPEAL OF GRAPHENE

Graphenea's CEO is Jesus de la Fuente, the consultant who suggested to Txema Pitarke getting involved in the synthesis and production of graphene. Graphenea's Scientific Director is Amaia Zurutuza (Bergara, 1975). Txema Pitarke brought her from Glasgow to Graphenea[55]:

–I invited her for an interview, helped by Andreas Berger and Luis Hueso, and then I made her an offer. She joined Graphenea in April 2010.

Amaia Zurutuza tells us how it all happened:

–I went to Glasgow, to Strathclyde University, as an Erasmus student. I spent a year there on the Erasmus program, three years doing

[55] NanoGUNE's group leaders are all male; but nanoGUNE's start-up companies have two female scientific directors: Amaia Zurutuza and Mercedes Vila.

my PhD, and three more working on a project. Then I went to a pharmaceutical company, where I worked for further six years on polymeric drug delivery; polymers were my field of expertise and had been during my PhD too. It was very interesting research! I had been abroad for twelve years, and I said to myself: "Maybe it's time for me to decide whether to stay or come back; let me see whether there's any interesting option in the Basque Country". I didn't want to go to Barcelona or Madrid; I wanted to try to make it here. I wanted to find something in my own field, polymers, in the area of biomedicine maybe. I looked around, but I found no companies in this field. And, all of a sudden, I saw an advertisement from nanoGUNE, where they were looking for a scientific director for a new graphene-production start-up company. I wondered what graphene was and looked it up on the Internet; it sounded interesting to me. I sent my CV on the off-chance. As luck would have it, there were not many people with graphene experience in 2009. I was selected for the post, and that is how I came to Graphenea, to a new world.

–Did anybody else apply to the job?

–Yes; and it's a funny story. At a conference, I met two candidates who had been interviewed for the job. Most of the people who had applied had little experience with graphene; one of them did have some experience, but he was older, he lived in the US, and worked for a large company[56]. And this, after all, was a risky project, full of uncertainty; nobody knew whether it would work out or not.

–What are your responsibilities as Graphenea's scientific director?

–It has changed a lot since I started here. At first, it was just me, so I had to do everything: secretarial work, purchases, sales, everything.

[56] He was one of the authors of the paper that had been published in *Science* in June 2009 on CVD graphene. He worked at Texas Instruments. In January 2010, Txema Pitarke made him an offer that he turned down. At that point, there was a kind of a crisis, but Txema chose to carry on with the project with the help of external consultants. Thanks to Luis Hueso's contacts, Pitarke hired as consultant Manish Chhowalla, who at the time was moving from the US to Imperial College, London.

It was like that until we put together the research team and started to develop things a bit. What is my job now? I lead the research program. Graphenea makes samples and sells them to researchers at universities or companies. I also submit research proposals for funding; once they are accepted, I do the follow up of the research projects and make them happen. I find it a very interesting job.

–How many of you are there at Graphenea?

–At present, there are 26 of us. For the first few years there were just five of us; we were all scientists, and we had to do all sorts of things. Now, we have a finance department, marketing, sales. We have an office in the US, and our general manager, Jesus de la Fuente, lives there. We do a lot of Skype calls, and he comes here every two months for a week. He says we should be delocalized worldwide. He's very modern.

–Graphenea was nanoGUNE's first start-up company and also the first one to fly solo.

–In 2018, we went to our new headquarters at Miramon technology park. However, we still come to nanoGUNE a lot: we use the equipment here, we collaborate with some of the group leaders, we're always in touch. We were the first experiment, it worked, and I think there are other good examples at nanoGUNE, for example BioTech Foods.

STEAKS AND A SURFER

BioTech Foods is company number six, the latest of nanoGUNE's start-up companies, and the best known, at least in the media. In fact, growing cultured meet, protein, is very intriguing for many people. And in this case, the process of setting up the company was full of twists and turns. In fact, Txema Pitarke refers to nanoGUNE's start-up companies as 5 plus 1, because while the first five start-up companies are very much the result of nanoGUNE's know-how, number six came about indirectly. A surfer from Madrid, Mercedes Vila, was in the mix. Pitarke brought her over from the University of Aveiro to Ctech-nano,

nanoGUNE's third spin-off company, as scientific director. While at Ctech-nano, Vila came to Txema Pitarke with a proposal.

–Someone from the food business asked Merche about the idea of growing cultured meat. This is, actually, all about tissue engineering, so Merche, who had experience in that, said she would know how to do it. She came to me with the idea, and I quickly realized that it was a great opportunity as it was about the right time to start something like that. The people who had the original idea, including Merche, founded the company, and we joined shortly after, together with a local company, InterAlloys, that was prepared to put up some capital. In this field, you need to handle with a number of techniques in which we are knowledgable, mostly characterization techniques to measure the properties of the samples. Here at nanoGUNE, we have that knowledge and the scientific equipment required to do that, electron microscopy and so on. The company was founded in 2017. With our in-kind contribution, we took 10% of the company. Two years later, in 2019, a very significant capital increase took place.

–Is growing meat a bit like growing lettuce in the garden?

–What we need here are stem cells. Growing plants requires two things, seeds and soil. Seed and the substrate. The same thing is true here: the seeds, the stem cells, are extracted from livestock, pigs and chickens in our case. Once you have the stem cells, you put them on a substrate and let them grow.

–But are we talking about nanotechnology?

–Not so much. Cells are rather large from the nanoscale perspective. The diameter of animal cells is typically between 10 and 100 microns, and one micron equals one thousand nanometers. Cells are not at the nanoscale; but for the characterization of the tissue that is grown here, you do need to use the kind of characterization tools that we use in the field of nanotechnology here at nanoGUNE. These things are being done all around the world; but not in very many laboratories yet. We believe that in this field, too, we can be pioneers and competitive.

ATOMISTIC SIMULATIONS

After Graphenea, in 2014 nanoGUNE launched Simune, the spin-off company that carries out atomistic simulations. Pitarke tells us how it all started:

–We made an offer to Emilio Artacho to join us at nanoGUNE. He was a professor in Cambridge, and we opened a new research group for him here, a theory group. There was no competition in this case; he was the only candidate. Artacho and two other researchers, Pablo Ordejon and Jose Soler, made a very important contribution in the 90s. Daniel Sanchez-Portal too, while he was working on his PhD under Soler's supervision. At the time, they were all at the Autonomous University of Madrid; they were young physicists. They developed a new code for carrying out atomistic simulations. It was an implementation of a computational framework, Density Functional Theory, that was hot stuff at the time. In this framework, calculations could be made to predict the properties of existing materials, discover new properties, and make progress in the design of new materials. The code developed in Madrid was called Siesta[57]. It was released for free to academics at universities and research centers; the only condition was to cite the research paper they had published with the code. At the same time, they brought the code out into the market for companies through a spin-off company of the Autonomous University of Madrid that was dedicated to the development and commercialization of atomic-force microscopes; but there was little demand. When Artacho came to nanoGUNE, he said to me: "Instead of selling the software, we could do the simulations ourselves; let the companies tell us what they need, and we'll carry out the simulation".

–So your plan was to offer the service.

–Precisely. Along with nanoGUNE, Simune's founders were Artacho, Ordejon, Soler, and another physicist, Juanjo Palacios, professor of physics at the Autonomous University of Madrid. Moving forward with a company like that calls for somebody with a business

[57] SIESTA: Spanish Initiative for Electronic Simulations with Thousands of Atoms.

perspective. Scientists sometimes don't have the business skills and experience that are needed to run a company. We needed someone who, in addition to managing the company on a day-to-day basis, would have a clear vision of the strategy to be followed.

–A leader?

–A business leader. You can do nothing without a person like that, even with the best technology in the world. We went all over looking for the right person, and, finally, we found Daniel Simo, an electronics engineer. He had been working in the US as an SPRI representative, and he had returned to the Basque Country to take over his family business, a publishing distribution business based in Bilbao. Since Simo joined us, Simune has been doing pretty well; sales are already starting to pour in.

Pitarke with Simune's co-founders Ordejon, Soler, and Artacho (2014).

THE THINNEST LAYERS AND THE OLDEST ENZYMES

–The third company is Ctech-nano.

–This was the initiative of the Nanomaterials group leader, Mato Knez. He is Croatian; well, I think he was born in Germany, or at least he grew up there, but he is Croatian! Mato is a world expert in Atomic Layer Deposition (ALD). We founded Ctech-nano as a joint

venture with two local companies from Gipuzkoa: AVS in Elgoibar, with Miguel Angel Carrera in charge, and Cadinox in Belauntza, with Andoni Isasti in charge. Back then, our TechTransfer manager was Miryam Asuncion, who brought these two companies on board. The ALD technique has been used for many years, mainly in the semiconductor industry for a highly controlled deposition of thin films on integrated circuits. We thought it was the right time to bring this technique into other fields; using it, you can deposit very thin films at the nanoscale and in a very controlled way. AVS develops scientific equipment, and Cadinox is a stainless steel boilermaker. We needed them both because the manufacturing of scientific equipment requires industrial boilermaking. Among our clients there are companies such as Repsol and the FNMT (Fábrica Nacional de Moneda y Timbre – the Spanish State Mint). Until present, the necessary resources have been put in place by our industrial partners and by us, and now we are looking for investors.

–Evolgene, company number four, takes us back to the most ancient enzymes.

–From the very beginning of nanoGUNE's existence, we always wanted to tackle the nanobio field; but we never thought we would end up developing and commercializing ancient enzymes (enzymes are proteins that accelerate or catalyze chemical reactions). The world is not linear. Research is not linear either, not at least at the level of fundamental research. Evolgene was initiated somehow when we brought over Raul Perez-Jimenez, originally from Granada, to open a new research group in the area of nanobiolotechnology. At the time, Raul was in the US, at Columbia University, and here we had a position available to lead the Nanobiotechnology group. One year after Raul came in, in 2014, something happened. Repsol launched a call for proposals from start-up companies offering innovative solutions in areas of their interest. Raul put forward the idea of producing biofuel using ancestral enzymes. He had filed a patent at Columbia University

about the recovery of ancient enzymes, enzymes that existed billions[58] of years ago but are no longer around today.

–Enzymes from billions of years ago?

–How old is the universe? The universe is somewhere between ten and fifteen billion years old. These enzymes were there a few billion years ago; but evolution made them disappear, as they were not needed anymore. Nature does not need those enzymes anymore; that is why they disappeared long ago. In industrial processes, however, extreme conditions may occur that do not currently take place in nature, and it may well be that ancient enzymes are very efficient in those industrial processes, much more efficient than current enzymes. That may well happen, and we are proving it does happen. Raul and his research group bring enzymes from billions of years ago back to life to be used in various industrial processes.

–And how do they reconstruct them?

–With the use of bioinformatics and phylogeny. Starting with genetic information for current enzymes, the phylogenetic trees of existing organisms are inferred in the same way we do to find our ancestors. The genetic sequence, the fingerprint, of ancestral enzymes is then reconstructed, and with that information at hand molecular biology is used to synthesize those enzymes in the laboratory. These ancestral enzymes are then tested on industrial processes to determine their efficiency.

–All that to make biofuel?

–At that point, in the project with Repsol, we wanted to use ancestral enzymes for biofuel production. Now we are reconstructing ancient enzymes for other purposes as well. When the project with Repsol was over, we reached an *impasse*. Then, in 2018, the project was reconsidered with a new focus: the reconstruction of ancestral enzymes for the production and sale of nanocellulose. Nowadays, there is growing interest in cellulose (an organic compound making

[58] US billion, which equals a thousand million.

up wood for example) nanocomposites. What we produce is nanocellulose, which is cellulose structured at the nanoscale, at the scale of atoms and molecules. Thanks to this nanostructurization, nanocellulose has properties well beyond those of regular cellulose, new properties that may be useful in many fields.

–What is nanocellulose used for?

–There are a number of applications for recycling, composites, the food industry, cosmetics, drugs… Now, we are mixing our nanocellulose with graphene to make ink and use it in sensors in a collaboration with a local company. Nanocellulose combines high mechanical strength, biocompatibility, resistance to degradation, and high water-absorption capacity. It also has a kind of electrical properties. By mixing it with graphene, it can be used in coatings, batteries, and sensors, for example. Right now, we are reconstructing another types of ancestral enzymes that could be used in biomedicine and cosmetics.

THE PROSPEROUS FUTURE OF A NANOMEMBRANE

–The fifth company is Prospero.

–I was in touch with a US professor, Robert Blick. He's German. Since the very beginning of his scientific career in Germany, he had been publishing very important research papers; he is a great scientist. He moved to the US, to Madison, to the University of Wisconsin-Madison. He wanted to come back to Europe: his wife is from Madrid, a physicist from a different field. So I offered him the position that would later be taken by Raul, to lead the nanobiotechnology research group. Blick had another very good offer in Hamburg to become the director of a new center, and he went there. At the time, he had a newly created company in the US, Prospero Biosciences, which had not yet started operation. We discussed the possibility of starting a new company here, and I made him an offer: we would open a new laboratory at nanoGUNE, and we would hire two post-doctoral researchers, Maria Arbulu and Brazilian Thales de Oliveira, who had just finished his PhD with us.

–So it was about bringing the company here.

–It was more complicated than that. Blick was the founder of the company, but the foundation managing the intellectual property of the University of Wisconsin, WARF, was also a shareholder and was the owner of the patents protecting Blick's technology. In the end, we founded a new company here in the Basque Country, Prospero Biosciences SL, which acquired the American company.

–So you bought it?

–Yes, it was an acquisition. The newly founded Basque Prospero took over a major part of the shares of the American company. Now we own around 90% of the American Prospero; the remainder belongs to WARF. We thought it would be a good idea to have a subsidiary in the US.

–What does Prospero do?

–Prospero's activity is related to mass spectrometry, which is used for determining masses of particles, for example proteins. By measuring their mass, you can learn about their structure and function, and you can also analyze their amino-acid sequencing. On forensic crime TV series such as *CSI*[59], this type of equipment often makes an appearance. It's a very important medical technique all over the world; it is used by forensic physicians, and also in research and healthcare. The use of this equipment is very widespread, but there is a limitation: high-mass proteins cannot be identified; there is something missing there. In order to be able to detect high-mass proteins, Blick devised a new technique, a new detection process, a new process based on field emission and involving a membrane. It can be a silicon membrane; but it has to be a few nanometers thick, so you need a nanomembrane. That is what Blick's patent is about.

–So Prospero is making that nanomembrane.

–We are manufacturing the nanomembrane and also the detector containing it. We're still having problems: the technique works, but

[59] *CSI*: Crime Scene Investigation television series (CBS, 2000).

we haven't managed to scale it and make it reproducible. We still have more research to do. If it works out, this might be one of our best companies. It has a great future and a very large, promising market.

PATENT COMMERCIALIZATION

–One more thing: patents.

–In a research center like ours, we file patents when our inventions have the potential to become commercial propositions. Patents officially state that the invention is ours, and that no one else can use it without buying from us the right to do so. This protected technology is usually taken to market by a company, once the patent is bought to us or a license agreement is signed. The patent does not belong to the researcher, it belongs to nanoGUNE; nanoGUNE will then pay the researcher a percentage of the net income from the patent. Right now, we own twenty patents, and we are already licensing half of them. Some are licensed to our own spin-off companies; others are licensed to the German company Neaspec, for example, which was co-founded by our group leader Rainer Hillenbrand just before he joined us here at nanoGUNE; another patent is jointly owned with and licensed to Das-nano, a company from Navarre. That company, founded by Esteban Morras, is based in Zizur. They do many things in the field of engineering, and the company is growing very successfully. Thanks to our joint patent, Das-nano is taking a tool to market that measures the properties of graphene in order to check whether a given sample is actually pure graphene. We would like this joint technology to become a worlwide standard. A few of those tools have been sold already. These are just a few examples; there are more companies making use of our technology portfolio.

–So you have another connection with Navarre besides Etxenike.

–The Basque government expects us to collaborate, in particular, with companies that are based in the Basque Autonomous Community; companies from Navarre do not count. For our performance metric, as requested to us by the Basque government, Intel and Das-nano both

go in the same bag; they are both foreign companies, as they are both from outside the Basque Autonomous Community.

TECHNOLOGY TRANSFER

Ainara Garcia-Gallastegui (Elorrio, 1980) has been nanoGUNE's TechTransfer manager since 2018. What does the job involve? Ainara responds with some examples.

–Technology transfer examines all the useful ideas within the center, that is, all the ideas that may be worth taking to market. Our research here is fundamental to some extent. Some fundamental research can be taken to market, and, conversely, some applied research has no place in the market. For example, we are doing fundamental research for one of our clients: the spintronics program we have with Intel. Nothing can be more fundamental research than that. Something like that could be a PhD thesis; but this kind of research could become the basis for the development of Intel's own technology. Intel hires us because we are doing cutting-edge fundamental research. In addition to that, we have another type of research related to sensorization and monitorization procedures, which has a clear application in hospitals and other sectors. When we see there is something that may be of interest for industry or for hospitals, something that may be profitable, we transfer it. It is clear that we are a research center, and, consequently, we function, to some extent, like a university. Publications are the basis for an international research center like ours. In this area, we see nanoGUNE as a worldwide pioneer. We see this in all the papers we have been publishing in high-impact journals such as *Science* and *Nature*. In that regard, we are at the same standard as MIT, Cambridge, or Imperial College, for example.

–At the highest standard.

–We are up there with the best centers in the world. As a research center, that is what we do: PhD theses, publications. But there is another facet, which is technology transfer. There are three pillars to technology transfer. One pillar is direct collaboration with industry through contract research. In other words, industry hires

us for a specific service or to develop technology that is of interest to them. Another pillar is the creation of spin-off companies. And the third pillar is about patents. It is obvious that certain technologies have to be protected: they may be of interest to big companies, big pharmaceuticals, or big players, those companies with enough money to take over and license technologies. NanoGUNE is committed to protecting its own technology. Right now, we have twenty patent requests ongoing, and that's a very good number in proportion. Whenever we see that our technology can spark interest in the market, we protect it. Then we approach investors or companies and tell them about that technology. They can make a profit from using our technology, and we can make a profit from our licensing rights. That's how research works nowadays.

–You've been at nanoGUNE since 2018. Do you design your own work plan?

–Back in England, I was already working on technology transfer, and I brought here what I learnt there over so many years. Txema trusted me from the very beginning, and he usually agrees with my proposals, so I have been able to design the technology-transfer plan fluidly, always coordinating with him.

–How do you see the relationship between fundamental research and industry?

–The research we do at nanoGUNE is world-renowned top research. Obviously, the Basque government would like this to be transferred to local industry, and I completely agree. I never forget that goal, but I do also think in international terms. We have a strong industrial base here with a major historical tradition; but when it comes to applying our research to industry here, there is a gap! There are technology centers such as Tecnalia, Tekniker, and CEIT, for example, which have been working closely with the industry here for years; they know what industry needs and how to respond to its needs. We can support those technology centers.

–Do you mean technology transfer in stages, step by step?

–Exactly. In technology, that's called TRL, Technology Readiness Level, which is a given technology's level of technological maturity, and that is measured from one to ten. NanoGUNE stands between one and five, which means we can carry out a proof of concept, but we cannot go as far as making a prototype. We can get to the point where we can prove the technology works; so without going directly to companies, we can collaborate with industry through technology centers. We have another line: as part of the Elkartek program, the Basque government provides funding that we use to collaborate with technology centers in order to provide industry with real solutions. We lead the research projects of this call.

–You are working with Intel, too. You emphasize the need to collaborate with companies internationally. Is there still more to do in that sense?

–Yes, there is still much more to do. Our focus is on big companies working with MIT, Cambridge, or Imperial College. The fact is that nanoGUNE has limited means, so we cannot do everything. A strategy is needed to determine which part of our resources we use to work with technology centers in order to transfer technology to industry here, and which part we use internationally in order to make nanoGUNE a center of international renown, a point of reference. We are doing very well, but there is still room for improvement. We have to make ourselves more visible in Europe, because we can't yet go to Brussels and say: "Look, we're working with Intel". The research we are doing here can be useful for this kind of big companies.

–So you plan to push hard in that direction.

–That's right. What are our points of reference? Silicon Valley, for example; but there is a different structure there, where companies go and settle around research centers. Cambridge follows that example. In Cambridge, in a gigantic area, you can find everything: companies, research centers, the university… They combine art and science too, in order to bring science to society. The way it works is very interesting.

–It's often said that companies here don't demand research.

–Research is strategic investment made for the long term, so perspective is necessary, as is a desire to undertake such long-range projections. Here, companies that are set on their course, companies that are doing well, are afraid of considering such long-term investments. This is to be expected; but it does show that they lack a certain way of looking at things. If you invest a little in research, taking into account that the Basque government will provide funding for that, your production will improve in ten years' time. I'm talking about traditional Basque industry, the machine-tools industry. However, trends are changing here too.

–For instance?

–The Basque Health Cluster was set up a few years ago, and it is quite active. There are a lot of small companies in the bio sector. That is a natural tendency in Europe. As a matter of fact, Europe is leading the way in deciding where to spend the money: Alzheimer's, cancer… In that way, it points out the paths we need to follow. The dynamics of the cluster have nothing to do with those of traditional industries: there are small companies in the cluster, companies that aim for product improvement through research. When you tell them: "Look, I've got this technology", they listen to you and are ready to work together. It's a different mentality and a different way of doing things, more like in Cambridge. That's just an example. What matters here is that, beyond big industries, new global tendencies are emerging.

–The Basque government is closely aligned with the path marked by European institutions.

–Yes, the strategy of the Basque government is very clear; it aligns well with what's being done in Europe right now. I'm optimistic. Maybe because I bring new strength to the picture. You need strength. And yet, in the year and a half I've been here, I have sometimes felt like saying: "Enough is enough; I can't do this anymore". You need to push all the time. I understand that if you're in your own bubble and someone comes and tells you that there is a way out, let's do it, it just takes you a bit out of your confort zone.

–You make them uncomfortable?

–Absolutely! But I get along with everybody. I might be optimistic; but since I came here, the results are obvious: we have a customer portfolio, and this year we will be able to reach the target required by the Basque government. Now 10% of our total income comes from private funding, as required by the Basque government as a minimum, 30% being the final target. For the first six months, some of the group leaders didn't want to have me around, I was a problem for them: they were doing fundamental research and wanted to be left alone, because they had enough supervising PhD students and so on. I came from England, from a company that worked with Imperial College and University College, London, where things were very different. Over there, I would go to the offices of the group leaders and they would open the door to me, we would have coffee… I was useful to them. They had their basic research, which eventually could be taken to market. For them, I was the means through which their work became visible to industry, to companies. Now, even here, they come to me and say that my office feels like the doctor's surgery.

–Can you give me an example of how fundamental research and industry can go together?

–The best example is our collaboration with Intel. The research we are doing for Intel is about understanding how electrons can be arranged in order to improve the capabilities of their electronic devices. It is our model project.

SEVENTH CHAPTER
OUTREACH

COMMUNICATION IS KEY

Etxenike: I think we scientists have a duty to explain what we do; why we do what we do, what the purpose of what we do is, how it benefits society. And, in order to do that, we need to allocate some time for communication.

Pedro Etxenike is a firm believer in that, and will hardly ever refuse to speak to the media or turn down the opportunity to give a lecture. Besides, he is an excellent communicator, able to make even the most difficult concepts easily understandable. He has a broad perspective on communication. One result of that is the *Passion4Knowledge* week, which the DIPC organizes and which serves to promote scientific knowledge. During that week, high-ranking scientists, including Nobel-Prize winners, come in contact with the public. One of the key features of 'the Etxenike ecosystem' (the DIPC, the Materials Physics Center, nanoGUNE) is its commitment to an habit of communicating with society. NanoGUNE fits this paradigm perfectly well.

Igor Campillo was nanoGUNE's first outreach manager. He has a PhD in physics, he completed his first year of a master in science communication, and he told Txema Pitarke that the research center they were about to set up should take care of that area:

–My plan was to leave Labein-Tecnalia and work on science communication. In the summer of 2005, I explained it to Pitarke and Etxenike in the conversations I had with them.

–Where did all that come from?

–I like writing, speaking in public, and science, of course. I was familiar with communication initiatives that were taking place in other countries. For example, in the English-speaking tradition scientific outreach, projecting science towards society, is very important. In Spain, there has been a boom in science communication over the last ten or twelve years. I had a strong scientific career, I had completed

my PhD, and I was doing research; but people change along the course of a lifetime, and I wanted to get into communication. Also take into account that we were at the start of the digital era, and that scientific outreach is very closely connected with the spread of digitization. My instinct told me there was a fertile ground there for me to develop professionally.

–In 2009-2010 you coordinated the *Atom by Atom* and *Passion-4Knowledge* scientific-outreach encounters.

–Communicating science and scientific outreach serve to explain what you're doing. This kind of center has a responsibility towards society. Who pays for nanoGUNE, for the DIPC, or the University? Mostly, they exist thanks to public funding; other than publishing in journals like *Nature* and *Science*, and developing different projects, what is our debt to society? We need to give back to society. In order for science to be science, researchers must share their research with the scientific community, because that validates their work. Science cannot be understood without communication. A center like nanoGUNE had to have an outreach program.

COMMUNICATION AND SOCIETY

Igor Campillo led the first steps of nanoGUNE's communication program. Since September 2012, Itziar Otegui has been nanoGUNE's outreach manager.

–Around May 2012, nanoGUNE advertised a position: they were looking for an outreach manager. I was in Paris at the time, doing a postgraduate in science communication at the Spanish National Distance Education University (UNED). At the same time, I was working at a research center, INRIA (Institut National de Reserche en Science et Technologies du Numérique), which is, in fact, a large network of French research centers. I was at the Rocquencourt headquarters, and I was part of the communications team. When I saw nanoGUNE's offer, I thought it was very interesting. Actually, I knew the center, because I am originally from San Sebastian, from the Antigua neighborhood. I had seen it come into the world. When

nanoGUNE was being built in 2008, I was working here in San Sebastian at a communications company at Ibaeta, and I had been watching it grow ever since. I sent my curriculum to apply for the position, and I got hired. I left Paris and came back home. I started to work at nanoGUNE on September 1st 2012.

–Did you already have an interest in science?

–Yes, I did. I didn't study science, my degree is in humanities: I studied sociology and communication at Deusto University in San Sebastian, and, after that, I worked in corporate and institutional communication services. I could see things moving around me in the sciences too, in San Sebastian, in the Basque Country, and I found all of that really interesting. On the other hand, my partner is a researcher; he studied physics at the University of the Basque Country, at the Leioa campus, and I have always been curious about science. In 2005, we attended a big event at Kursaal, in San Sebastian, that the DIPC had organized about Einstein. When nanoGUNE organized the *Atom by Atom* conference in 2009, I was there too. I was interested, I felt curious about all that; and as far as the realm of communications go, I thought there was a lot to do in the world of science and research, in outreach, in processes geared towards society, and so on. And so I said to myself "Why not?".

–When you came to nanoGUNE, you didn't start from scratch.

–Not at all; Igor Campillo had been nanoGUNE's first outreach manager. As part of nanoGUNE's opening ceremony, in 2009, nanoGUNE and the DIPC organized the *Atom by Atom* conference, which, from the point of view of scientific projection, was their way of sharing everything, the inauguration of the center itself and the entire research project. From the very beginning, it was one of nanoGUNE's missions to promote scientific knowledge and bring it to society. So, no, I didn't start from scratch. After Igor Campillo left nanoGUNE, there was another person, Enrique Zarate. When I arrived, there were visiting programs for schools already in place, for example. There was also a training course for high-school teachers connected to nanotechnology, part of the Berritzegune training program that had

been put in place by the Basque government. And, in addition to that, they already had a close relationship with the media.

–How do you structure your work?

–My work involves providing the public with information about our day-to-day activities through our website and social media; that is one part of my duties. On the other hand, when we find that our ongoing research should be disseminated to the general public, we send it out to the media. And, finally, we organize specific projects, events, and activities throughout the year; lectures, exhibitions, and special events. These activities are sometimes run directly by nanoGUNE; on other ocassions we participate in projects organized by other institutions. For example, we take part in the science fair that the Elhuyar Foundation organizes in May each year and in the science week that the University of the Basque Country hosts every November. We have our own space at that event, and we take science to society in the easiest possible way.

–You've also used comic books.

–Yes, *nanoKOMIK*; we did that for two years. And the *10alamenos9* festival, which we hold with key partners from other areas. Here in the Basque Country, usually around April, we organize a series of events to explain the utility and complexity of nanotechnology to the public. In short, we have three fields of activity: our social media, our work with traditional media, and our events. We also have our corporate publications, the activity report we publish every two years, for example, projects…

–It must be hard for you to get onto the television news.

–Not because of any lack of interest in the center. When we have a celebration, like the tenth anniversary event, it is very well reported on the news, and by taking advantage of those occasions we explain what we are doing at nanoGUNE, how we benefit society. That's a good news story, and it's great. It's usually harder to communicate the results of a particular piece of research. Our results do not immediately materialize themselves in a product that is going to be on the market

tomorrow or the day after; what we usually do is take the step previous to that. Also, we have a problem from an image perspective, because those things are not visible, and the television needs images. Anyhow, it is enjoyable to show the labs and so on; we work in an interesting environment that is visually beautiful too. But then, our subjects are usually very technical and complex, and talking about them in 30 seconds… All that makes communication difficult. Sometimes you might be tempted to simplify: "Let's say this thing will be useful in such-and-such a way tomorrow"; but what if that doesn't happen? It's risky, and you can end up sensationalizing things. So we have to find a balance. Other times, we might be close to filing a patent or taking an important product to market, and in instances like that we have to protect our interests: we can't talk about it at all.

Sonia Arnes, Pitarke, Lorena Montejo, and Diez-Muiño with the winners of the *Nanokomik* competition (10-06-2016).

THINGS THAT CANNOT BE SHARED

–In other words, you have to be careful with the information you have.

–Our research usually doesn't have uncomfortable ethical implications; it's not controversial. If it's far from applications, it's rather harmless. However, the closer we get to applications, the more evident these kinds of things become, so they need to be taken into account. Some of our research is harmless; but the technical complexity is huge. People understand better if they see the application, if they see that the question "What is it for?" can be answered. That requires a bit of pedagogical work. Why do we need to do fundamental research? Because if we don't, our knowledge will be exhausted at some point, and then there'll be no innovation, no change of paradigm, no disruptive technologies, we'll keep on repeating these things *ad nauseam*. I have heard Etxenike and others say: "We would have never come across electricity by doing research on the candle; if we had been looking at the candle in search for new lighting technologies, we would have never invented the bulb".

–How do you manage to sell fundamental research?

–Actually, the scientists we have here at nanoGUNE are convinced that communication is very important. For example, in the Science Week held just a few days ago, we had a stand together with the DIPC and the Materials Physics Center. Forty volunteers took turns running the stand, happy to explain their work to the public. They love what they do, and they love to explain it; they love explaining to the public what they know about a material or about its performance. Many scientists, though not all of them, really enjoy opportunities like these. And that's just wonderful. It's harder for them to face the media, to stand in front of a microphone; and if there is a camera, forget it. But usually we have been able to respond to the media's requests.

–What message would you like to convey?

–I would like people around us to know that in the Basque Country we have world-class research centers, that nanoGUNE is one of

them, and that this is something to be proud of. As a matter of fact, nanoGUNE's research is being published in the very best journals in the world, and we have some very renowned partners in our projects, for example the University of Oxford.

–Do people have a good impression of nanoGUNE?

–I've noticed two things. Sometimes, when you mention nanoGUNE, some people are familiar with it and their reaction is positive. Others simply don't know about it. I don't have any objective data; we haven't done any polling on how well known we are. I have the feeling we've always been positively portrayed in the media, and that makes an impression. What's more, people are grateful for the events we organize; we've had open-doors sessions, which have always been fully attended. We offer about one hundred tickets, and usually they get taken up straight away. People always want to come; they come and spend two hours visiting the center, listening to explanations. When you walk into a researcher's laboratory, they show you their treasure and explain it to you. People become really interested, and they leave with a good feeling about the place.

–What is the visitors' typical profile?

–We get all sorts of people; but most of them are over twenty. Sometimes we see a mother or a father with their children of seventeen or so who are about to start university; we might get university students who are doing a science degree; and there are always retired people too, more for the lectures than for the visits.

–How do you interpret the success of the *Passion4Knowledge* encounters organized by the DIPC?

–That has been such an achievement; they make science prestigious. Science is culture; in order to be a cultured person, you must be prepared to learn about science too, at least open your mind to it. These encounters have become one of those places to be. Publicly-driven research centers belong to everyone, so it's important to give back to society. If we don't have a scientifically cultured society, or at least a society that understands the value of science, we won't have any

science, and then that part of the system will be at risk. This process of societal awareness is not something that nanoGUNE can do alone; all research centers and universities should be doing this together.

–Is there a network for that?

–Yes, in an informal sort of way. The CICs, for example, have a biannual publication, the so-called *CICNetwork*. On the other hand, all CICs, the DIPC, and the Center for Materials Physics, among others, support each other and work together. Our messages are usually one and the same.

Front page of the *CICNetwork* magazine.

–What is different about being the outreach manager of a scientific center?

–Communication specialists in research centers or universities tend to have one of two profiles: some come from the world of science, and others from journalism. In my opinion, those profiles

are complementary, they each have their strengths. If the outreach manager of a center like this is a scientist, working together with the researchers will still be necessary. It will be easier for a scientist to figure things out, but in either case the outreach manager always needs the researchers: their involvement is indispensable. The researchers work on very specific issues; in many instances, very few other people or groups in the world are working on the same issue. We need their words to explain what is going on there, why they are doing it, what they expect to find out, why it is interesting or innovative, what contribution it makes to the creation of knowledge… We share that experience together.

–Is it hard to understand each other?

–Sometimes I feel I see the material itself, while they have the nanoscale glasses on. Artists probably see or feel their world differently; researchers do too, but the artist's glasses are personalized, unique, emotional perhaps, while the researcher's glasses are based on specific knowledge that is shared with others. Science is collective; it could never be individual. There are some individual contributions, of course, which is why some receive a Nobel prize and others do not; but the discoveries of a Nobel-Prize winner are for everybody: once they discover something, it is shared with everybody.

MORE ON THE BINOMIAL

It is Etxenike's turn:

–What do people need to know about science?

–Firstly, the basic concepts of science: the atom is larger than the electron; the nucleus within the atom is small, but made of dense matter; and, in a different area, that antibiotics have no effect on viruses. Secondly, what is true and what is not true; homeopathy, for example, is not science. And thirdly, what are the economic and social effects of science? These ideas have to be enlarged on. That is what we are doing now, for example, in the *Kimikoteka* project, using wine as

a pretext to get to know the periodic table, and in the 'Cinema and Science' film cycle, and the *Passion4Knowledge* encounters.

–Would you give a score to the scientific knowledge of our society?

–No, I wouldn't. There are some surveys, but I don't have the data. In any case, we are making a lot of progress; the crusade we undertook a few years ago is bearing fruit. San Sebastian is not just a city that produces science, it is also a city of science. That was an aspiration of mine which I shared in the speech that I gave when I was awarded the Gold Medal of the city of San Sebastian: San Sebastian has so much to offer; but I would like it to be an internationally renowned city of science as well. I said I wanted science to be present in our city, and I think we are achieving that. I find it surprising, however, that in a city founded to a large degree on science and technology local people have no comparable thirst for this kind of knowledge. It's true that not everything is science and technology, but it is important to emphasize that science forms part of modern humanism.

Along a similar vein, Igor Campillo asks the following question: "How do we want society to evolve? Should that evolution be based on science or on populism?" And then he suggests society should contribute to scientific research.

–That is something that might happen at a more advanced stage. It doesn't mean citizens will replace scientists, but there is a growing sense of a movement towards what is called citizen science. It's a very important concept: it means that science should not be done for society, but with society; for instance, when it comes to deciding what research to carry out. Why give priority to a particular project, what is more important? There are certain dynamics already in place that encourage citizen participation.

–Where do they do that kind of thing?

–It is starting to happen in central and northern Europe. And another trend is emerging too, in which citizens even take part in the research process itself. How? It may be as cohorts for certain research studies or by giving permission for your genome to be sampled. And it is not just about sampling it, but also about getting

involved in the process by receiving information and learning about what is being done. Another way to participate is to make your home network computer available to researchers who are exploring space, for example. This is not mainstream, but it is being developed in some places. Some processes can be carried out better than others using citizen participation. The European Commission is pushing this trend; there is a regulatory framework, Responsible Research and Innovation, which includes open science, citizen science, and the like. NanoGUNE has taken a few steps in that direction; its strategic plan is structured along these lines.

Amaia Zurutuza, Graphenea's scientific director, adds to this idea and explains the science-ethics binomial:

–There is a new awareness, which includes ethics; ethics are mentioned, for example, in all European projects. And another tendency is responsible innovation, in companies and beyond. For example, what is the purpose of this research you are undertaking? Will it have a military use? Can poorer countries take advantage of what you are doing? You have to keep these things in mind. Be careful that you don't oppress people in the project you are proposing to undertake. Responsible Innovation is a concept that is very present in big companies, especially in Europe.

EQUALITY PLAN

At nanoGUNE, there are fewer women than men, particularly in leadership positions, although there is a palpable change in the air. Maria Rezola, from her years-long perspective, emphasizes this:

–There are no female group leaders. However, there are many female PhD students. The number of foreign women has increased, including women from non-European countries. At the beginning, there were more men maybe, but the percentage of women has increased. It is also true that most of us in administration are women.

How is gender equality progressing at nanoGUNE? It's Txema Pitarke's turn to speak.

–In the past, gender equality was not as present as it is now. It's like that everywhere. Now it's much more present; I won't say that's enough, but we are nowadays better aware of the issue. At the beginning, when you saw in our presentation of the center that everyone on the advisory committee and all the group leaders were men, nobody said anything. People might have thought "They're all men", but no one said anything. Now it's different. We have had female candidates for our group-leader positions –we also sent some offers–, but not very many.

–Women are still underrepresented in the world of science.

–Partly, it might be a matter of time. When I was a student, there were very few women doing physics and engineering; now there are more. Since I started lecturing at the university, in 1984, the presence of women has grown considerably. In my first undergraduate year, we were about one hundred students of physics. How many were women? No more than ten. In the fourth and fifth year of the physics degree, there were two specializations: pure physics and automatics, which had more to do with engineering. In pure physics, we were four male and four female students. The number of male students went down from ninety to four, and among women it went down from ten to four. Anyhow, the number of women who after finishing the degree pursue a scientific career is still rather small. There are few female undergraduates, at least in physics, and then there are even fewer women who take on a scientific career.

–At what point do women quit science careers?

–The scientific career is a pyramid. There are typically many undergraduates and master students, a smaller number of PhD students and post-docs, and only a few of them will follow an academic career. During that process, many PhD students and post-docs quit their academic careers and go to industry. This is to be expected. Working in industry is neither better nor worse than working in academia, it's simply different. It is true, however, that more women than men leave the academic career, so we are missing something there. In principle, it's neither better nor worse for women: outside

the academy career path, professional development can be as good or better than in academia. In fact, it is academia that is losing something here: ideally, the whole system should be more gender balanced. We should make an effort to increase the presence of women in academia, for the sake of women and for the sake of men, for the sake of both. For everybody's benefit.

–Can you think of a reason to explain this imbalance?

–I am not sure, but that's the way it is. There's nothing wrong with leaving the scientific career, that's completely normal. But it would be good to see that not only the academic career but all options are better balanced from a gender perspective.

–So you suffer from the gender gap in academia.

–To date, we have not been able to attract women to lead our research groups. When you only have one gender in a certain tier, you're missing something. It's related to plurality. The behavior of males and females may be different to some extent, which might have an impact on our dynamics and the results we achieve. We are proud to have researchers from 26 countries all over the world; we never looked for that, it just happened. That diversity enriches our center, and a greater gender diversity would be beneficial as well; in other facets too, for instance in terms of content. We have always wanted to build an interdisciplinary center, with physicists, chemists, biologists, and engineers; that, too, is diversity. What we should do is establish the conditions for diversity, including gender diversity, to thrive naturally, on its own.

Now it's Itziar Otegui's turn. She was part of the team that worked on nanoGUNE's equality plan. She starts talking about women's scant presence in science.

–Taking into account the disciplines we cover, our percentages here are comparable to those in other places. In other words, we aren't worse than average. In the field of physics, there are fewer women all over Europe. There is also a vertical distribution, because, in our case, the group leaders are all male. In research centers working more on biology, percentages are more favorable to women, and, despite that, in some cases, the glass ceiling is still there in Europe, in the US, in all

places of reference. I think there is a movement now to analyze how to change the situation. There are examples in some countries. For instance, a physics professor from the Zernike Institute for Advanced Materials at the University of Groningen, Petra Rudolf, president of the European Physical Society, came here for a visit and told us how they started working proactively on this subject twenty years ago. From what she said, they have managed to change the situation, as they succeeded in attracting women to the world of physics. That's in the Netherlands. Here, I would say that this movement started to gain traction later. At nanoGUNE, a gender-equality committee was set up in 2018 on the initiative of a few female researchers. A diagnosis was put into action, and in 2019 we worked on a gender-equality plan. Some measures were put in place to create a more attractive work environment for women and, also, to enable women to have greater opportunities in their careers.

–Is the plan public?

–Not for now. At the moment it's an internal tool. We carried out an internal survey, for our diagnostic, and a few initiatives came from that. Many of them are about work conciliation, measures to reconcile personal and professional lives; other initiatives are more administrative. For example, through the data we collect we always know how many women and how many men are employed in the center, and now we also have a non-binary option. We are currently updating basic things like that, and we are developing a protocol against sexual harassment. We are also working on some basic tools to encourage women's professional development.

–Are quotas mentioned in the plan?

–No, our plan doesn't go down that way. There are examples of quotas in some other research centers. In Groningen, for instance, in the faculty I mentioned earlier, they opened a few professorships for women only. There are a few initiatives like these. On the other hand, in Switzerland, confronted with a similar situation, a traditionalist association made the case that it was discriminatory; but the court decided that it was not, that when there is recurrent implicit

discrimination, the implementation of these types of policies is not discriminatory, but, in fact, quite the opposite.

–You have been involved in the plan's design.

–Yes, I have. There were about ten of us, including three men, in the team; the committee members have changed over the time, though.

–Will the center adopt the plan?

–NanoGUNE made the diagnosis and endorses the plan. The gender-equality committee has followed up on the entire process, and the plan is implemented by the center.

What are the guidelines of the gender-equality plan? Txema Pitarke goes into the specifics:

–The plan has been structured into five action areas: organizational culture, recruitment, work-life balance, work environment, and research. We started in 2019, and the plan will run until 2022, with specific initiatives each year. I'm responsible for the plan, together with our outreach manager Itziar Otegui. The Gender-Equality Committee and a number of specific work teams help us with the follow-up to the plan. In total, we have 10 strategic objectives and 39 initiatives. I'm optimistic about the improvements and the benefits the plan will bring us.

SOME EXPERIENCES

Amaia Zurutuza, Graphenea's Scientific Director, spent twelve years in the UK, in Glasgow, studying and working. She has a long career in the world of science. She describes her own experience.

–Personally, I have had very positive experiences in my scientific life. I've never felt inferior or relegated for being a woman. I think many measures have been put in place to make that a reality. Are we equal? No, not yet. Look at nanoGUNE's group leaders: they're all men. Txema tries, but... In Spain, there was an inflexion point when women became part of evaluation panels; before that, all members were men, but now women have come up a bit. That's in the academic

world. In the pharmaceutical company where I worked, the research director was a woman. There is a little more parity in the UK. There too, they have been working on this issue; but they started earlier on.

–What are things like at Graphenea?

–We have many women, about 60 percent or so are women. In the research team there is only one man. Right now, we have two job openings, and most of the candidates are women; they have studied chemistry, physics, or materials science. In the past, ten or twenty years ago, very few women had PhDs; now there are nearly as many women as men. But the issue is that the closer you get to the top of the pyramid, the fewer women you find, although things are changing. Gradually.

–You seem to manage in that world easily, though.

–Yes, that's true. For example, I'm on the board of directors of the big 'Graphene Flagship' project, on the executive board. There are 155 members from 22 European countries; 60% are universities and research centers, and 40% are companies; there are many researchers. However, there are only a few women on the board of directors.

Coming back to the UK, Ainara Garcia, nanoGUNE's TechTransfer manager, gives us a different view on the role that women play over there.

–The UK is very class biased, very traditional, very sexist sometimes; women would often stay at home with the children. I couldn't believe it! My university colleagues, or the mothers of my children's schoolmates, would put their careers aside to stay at home. Why? Well, because you can't keep the pace London demands and be a mother at the same time. You have two choices: either a baby-sitter raises your kids, or you stop working. Do not even think about suggesting that the father stays at home! My daughter used to tell me: "You're the only mom who doesn't go to school to pick up her child". And I would tell her: "It's normal for me not to go to school to pick you up; you have to study to be like me".

But Ainara does have a major complaint, an important complaint in connection with the difficulties women encounter in the world of science: she had to abandon her research. Why?

–I gave up research because of a physical impediment. I got pregnant, and as nanotechnology and pregnancy don't go together, I had to stop doing research. Otherwise, I would have continued. That happened while I was at Imperial College, during my post-doc. A professor who at first treated me very badly said to me: "No way, you can't quit research". He wouldn't accept that I had to stop doing research...

(At this point, Ainara takes a break; it's hard for her to talk about this).

–...and then I decided to move into a management position without abandoning the world of research completely, as I always liked it so much.

–Couldn't you go back into research after your pregnancy?

–No, you get left behind. Everything moves so quickly, it's so competitive, it makes no sense to go on. I was really heartbroken. Being a woman became a physical obstacle. There's nothing you can do.

–And is that danger really proven?

–Yes, it is. I was working with X-rays, electron microscopy; there were nanoparticles everywhere... During pregnancy and lactation, you can't do any of that.

–Women and science are incompatible sometimes.

–A scientist's life is one of sacrifice, with little stability sometimes. It does not work according to the pattern that still rules in our society and in which women do most of the household work. Without children, perhaps, the difference would not be so big. In fact, the women I consider role models, and I am thinking of some women in London who have succeeded professionally, had no children. If you are not a mother, you can reach parity with men: society gives you the same opportunities.

EIGHTH CHAPTER
BALANCE AND CHALLENGES

FREEDOM TO FAIL

January 30th 2019 was nanoGUNE's 10th anniversary. The promoters and directors of the center are now taking the opportunity to go over that first decade. However, while they talk about the development and evolution of the center, the challenges facing the center became their main topic of conversation, which bore witness to the fact that they are looking ahead rather than to the past. The role that science and technology play and have to play in our society is also the topic of some of the conversations, as well as the COVID-19 pandemic that started in the spring of 2020. And the panorama facing science and scientists in the Basque Country is also discussed. Pedro Etxenike is the first to talk.

–In your tenth-anniversary speech, you said: "The success of nanoGUNE is built on strong foundations: solid experience at the forefront of science, and a solid relationship with members of the scientific elite". As a matter of fact, what you said, those two conditions, are something that you already had yourself.

–The research teams we have been creating here have followed the functioning parameters of the very best groups in the world. Someone with a PhD from Cambridge doesn't stay there as a professor, which is usual practice in some Spanish public and private universities, pursuing a life-long career in one single place. Not in our group; in our group it is essential to give up the idea of permanence and go out to the best research centers; our people live by that unwritten rule. Txema Pitarke himself went to the US, London, and Cambridge. Javier Aizpurua, now in China, travels around all the time: he spent some time in Goteborg (Sweden) and Washington DC, and is one of the leaders in Basque science. Ricardo Diez-Muiño, director of the DIPC, spent time in Bordeaux and Berkeley. Daniel Sanchez-Portal, director of the Materials Physics Center, went to Urbana-Champaign in the US. Aran Garcia-Lekue, who was recently appointed Jakiunde

Junior, spent some time in Liverpool and Berkeley, and she is now Ikerbasque research associate at the DIPC. The same is true for many other people; I can't mention them all.

–You laid down the path.

–That's the leadership and mission of the the group. Jesus Mari Ugalde, former President of Jakiunde, went abroad with grant money from Garaikoetxea's Basque government, as did Alberto Lopez-Basaguren, Mikel Prieto...

–And how did you learn all that?

–From a very young age, I used to read about the history of science; I wanted to study in Cambridge, at the Cavendish Laboratory. I studied there; but then I paid heed to Iparragirre's[60] maxim: "There are good places in all countries; but the heart says come back to the Basque Country". That was a sort of premonition. There were other people who thought this way: Pako Garmendia, for example. And some of them went to Germany, but they returned too soon. However, I stayed abroad for a longer time, which was good for me.

–Did you have any particular mentor?

–In Cambridge, I had John Pendry, and also Archie Howie and Volker Heine. In the US, Phil Anderson and Rufus Ritchie. In Barcelona, I had Pedro Pascual; and in Madrid, Alberto Galindo. Here, it was Koldo Mitxelena: I used to talk to him a lot. The truth is that there is always an idea, a vision behind everything moving forward in the right direction; but that vision is of no use unless there is a team of first-rate people to make it happen. We got it right with Pitarke, because he combines a remarkable intelligence with a tremendous capacity for initiative; and also stubbornness, if you want to describe it in a negative way, or tenacity, put in a positive way. And he also has a capacity for building relationships which, combined with his innate elegance, makes his personality very attractive. I call him Lord Pitarke

[60] Jose Maria Iparragirre: basque poet and writer; he is the author of the Basque anthem *Gernikako Arbola* (The Gernika tree).

because he's so laid back and elegant at the same time. I've been lucky to work with great collaborators.

–After all these years, have your expectations been fully met?

–We went well beyond our expectations at the Materials Physics Center, the DIPC, and nanoGUNE. The DIPC, over there twenty years, is being cited nearly eighteen thousand times per year in internationally renowned publications. That's why I think very few do more for the image of San Sebastian than the DIPC, which has Donostia in its name. Eighteen thousand papers citing you; there's no better propaganda than that, right? The same is true for nanoGUNE. I usually say that nanoGUNE has surpassed not only all my expectations, but also my dreams. When at the end of the 90s I explained to Txema, Ricardo, and other people what I wanted to do, which ended up being the DIPC, they used to say: "You're mad!". And, at the time, my expectations were much less ambitious than what we've already achieved.

–Have you seen any deviations from the original plan?

–All projects call for new decisions, course-corrections, and start-overs. That's one of the characteristics of science. It's a system of trial and error; but that's not something to be afraid of, because there's a lot to be learned even when things don't turn out right. And when the scale of a project is large, some things turn out well, and others do not. That's why one of our mottos is "Freedom to fail". That motto is part of our ecosystem.

–Where did you get it from?

–I don't know. I've always had it with me. I've always said: "Freedom to fail". I used to repeat to Txema that what matters is people and trusting people. I don't believe in the advice –with Excel sheets to measure production– of people who have never contributed to the topic in question. I don't believe in people telling others what to do when they've never done anything themselves. I believe in Napoleon: in battle you don't say "Go forward", you say "Follow me". I believe in trust and in people. I believe more in people than I do in projects, because I don't think projects about the future can be assessed. Given

a choice, I prefer a good person on a bad project, because a good person will make your project good. I don't want an excellent project that, in principle, anybody could do, and which then never happens. At nanoGUNE, the key has been to trust one person who has chosen excellent colleagues and has carried out an outstanding project.

Hernaez, Etxenike, Pitarke, and Ibarretxe at nanoGUNE's 10th anniversary celebration (30-01-2019).

LOCAL AND GLOBAL

President Ibarretxe has a couplet that he repeats time and again: science and soul. It is not merely a play on words, but the synthesis of a concept. When asked to appraise nanoGUNE, he takes a moment to think. His reflections touch on some habits in politics.

–In politics, success is sometimes evaluated before completion, and that's not fair. Sometimes you have to make decisions, in particular in the areas of scientific, technical, and social innovation. You need continuity. When addressing society, we are used to having to highlight results before an institution is launched, and that is wrong. Politics, and science too, prepare a country for the medium and long term, and often you have no time to explain what has happened. Now we know

that industrial restructuring was very important for this country; but in the early 80s, president Garaikoetxea's first government came under serious criticism, and later on president Ardanza's government, too, was heavily criticized. Nowadays, forty years later, we know that those people made decisions in very difficult circumstances, and those were the right decisions to make. I remember Giulio Andreotti, while he was at the European Union, saying: "Many institutions and officials were not fair in our assessment of the decisions that were being made by the Basque Country and its political institutions". Statistical series are needed to be able to truly evaluate these things. When it came to nanoGUNE, I had no doubt that it was a very important project and, of course, seeing the results, who has any doubts now?

–So expectations have been met.

–It is wonderful! Look, nobody wants to capitalize on failure, and everybody wants to capitalize on success. I remember the sort of criticism we got in this country about the Guggenheim Museum. Nowadays nobody criticizes it. It's better that way; let's not look back. Community capitalization of success is better. Failure is not usually communally shared, it tends to be allocated individually. That is to be expected: nobody wants to be involved with things that went wrong.

–The commitment to the creation of nanoGUNE was no small thing.

–In addition to my support to this particular project, I benefited from the collaboration of Txema and Etxenike on the definition of the whole science, technology, and innovation system. They were absolutely extraordinary collaborators in all the ideas that were being developed by the government for us to be positioned, at our level, as a reference in terms of R&D&I. We contributed to the implementation of the DIPC and its ecosystem, including nanoGUNE; and these people, most notably Pedro Miguel Etxenike, offered full-time assistance to the governments that I headed when it came to promoting the idea of R&D&C (Research, Development, and Culture). That is the formula for the future we set in motion in 2001. We realized one thing: we could learn from things that were being done in other parts of the world

within that polynomial of research, development, and innovation; but if we did not incorporate that into our way of understanding life, business, our narrative, our values, savings, family, sons, daughters, education…, the formula wouldn't work. The cultural side is crucial in order to achieve a harmonious economic development from a social perspective, and in order to achieve a sustainable social development as a result. That was, back then, the great contribution we made and received.

–You still have a close relationship with Etxenike.

–In the 60s, one used to talk about the two cultures; but, in fact, there is only one culture. There is no such a thing as a scientific and technological culture, on the one hand, and then a social culture on the other hand. There is one single culture, and that culture is social, scientific, and technological, innovation included. So Etxenike and I are committed to going, little by little, retracing the path that had been laid down at some point. I am now an economist fully aware of the importance of science and technology for a sustainable human development, and Etxenike is aware of the social dimension of innovation to achieve that development. In this sense, countries whose identity is clearly marked on their DNA move forward in better shape. What do Northern European countries like Finland, Sweden, and Norway do? In short, to be on the global agenda you need to provide local answers. And that is precisely what nanoGUNE is: a local response to a global challenge that puts us on the map.

CHALLENGES

Joseba Jauregizar looks at a certain facet of the praxis when appraising nanoGUNE.

–I wanted to go a bit further, but... According to the theoretical model I had seen, private funding would increase at a steady pace; but that has not been achieved completely, because it is quite difficult and there is also another problem: there is little demand from companies, while the technological level that is being developed by the CICs is

high. If the technological level of companies here were to rise, private funding would increase. It is important to sow that seed.

–Is it clear to you that nanoGUNE needs to do fundamental research?

–Market-oriented fundamental research; that's the small nuance I underline, because fundamental research is carried out by the BERCs[61], so I wanted to make that difference: nanoGUNE should be doing market-oriented basic reseach with an impact on industry.

–The center is moving in that direction, isn't it?

–Yes, but I would like to see a bit more. That's my vision. Anyhow, I am satisfied with the CICs, because there is a strong presence of researchers from the Basque Country and from abroad at bioGUNE, biomaGUNE, and nanoGUNE. Also at energiGUNE, although not so much there; it has been more difficult for them to recruit foreign researchers.

Igor Campillo also sees nanoGUNE as a research center that actively contributes to industry:

–Research in the field of nanoscience and nanotechnology may be disruptive in the sense that it may offer opportunities that would probably not emerge from other areas. On the other hand, nanoscience and nanotechnology are interdisciplinary: it isn't chemistry, it isn't biology, it isn't engineering, but all those disciplines are involved. NanoGUNE is, in fact, a very cross-disciplinary center; it is a suitable partner within any industrial sector. You see a company producing lab-grown meat, you may see another company manufacturing aircraft wings, or you can see a company working on electronics seeking to develop a faster chip. Nanoscience and nanotechnology are also expected to have a clear impact on the biomedical sector; in fact, that is expected to be one of the major areas of application for nanotechnology.

Etxenike recalls a heated dispute between two renowned scientists on how to integrate science and industry.

[61] BERC: Basque Excellence Research Center.

Nanobiotechnology laboratory.

–Anderson[62] recounts how Pippard[63] said "Our students are not being used by UK industry. The good ones are going overseas. So let's train them for UK industry. Instead of training UK industry to use our students, let's train the students for UK industry"; and he (Anderson) explained how that kind of thing drove him absolutely up the wall, because they had a beautifully organized syllabus in Cambridge that would be destroyed by such an attitude. According to Anderson, the training of scientists should not bow to the needs of the existing industry.

FUNDAMENTAL RESEARCH AND INDUSTRY

We have reached a sensitive point: the relationship between fundamental research and industry. This difficulty shows itself in one of the objectives set out by the Basque government's department of economic

[62] Philip Warren Anderson (1923-2020): American physicist, Physics Nobel Laureate (1977).
[63] Brian Pippard (1920-2008): British physicist, Cavendish professor (1971-1982).

development and infrastructure, according to which the center must obtain a 30% private funding. Pitarke sees it this way:

–At nanoGUNE, we should not be blinded by our cutting-edge fundamental research: we have to address the field of applications, as well. That is why we have always had, from the very beginning, a TechTransfer manager, who plays a key role in the center and keeps an eye on things, so she can say to the researchers at any time: "Look, we've got this possibility here, can we do it?". That's applied research. Fundamental research, on the other hand, is funded primarily by public agencies; but it can also be privately funded by companies, and that is ideal, because, in such a way, we help industry, mostly the industry of the future, and, at the same time, industry can open up new avenues for us in fundamental research, with its strategy and vision. Bringing this kind of funding is a key to success for us; but it's not easy. Another way of contributing to the economic development of our country is based on launching start-up companies as we did, for example, with Graphenea. These initiatives contribute to the economic development and well-being of our society both directly and indirectly. Directly, because new jobs are created, tax revenue increases, and, at the same time, new private funding will eventually arrive at nanoGUNE, allowing us to strengthen our research. Indirectly, because these newly-created start-up companies are located here in San Sebastian, in the Basque Country, so they contribute to the development of an environment that will be richer and more attractive to new talent and, also, to new initiatives coming from other parts of the world.

–You're talking about generating a pull effect.

–Not so much with a single company; but with several of them our country will become more attractive for talented people from all over the world. Thanks to this kind of projects, our country will make significant progress, and we will be seen as an attractive place for new endeavours. Besides, these things are contagious in a good sense, so they will bring us wealth in the mid and long term. But, of course, this is not just about one single company, and it is not about the next ten years. This is a challenge for at least a whole generation.

–So we're talking about designing long-term strategies.

–We're talking about putting in place and strengthening an ecosystem; that's where we need to make progress. Strengthening the industry of the present is fine, but we need to work with an eye on the industry of the future. Technology centers are working hand in hand mainly with the industry of the present. At nanoGUNE, we have to collaborate, of course, with technology centers and the industry of the present; but, above all, we have to take the industry of the future into account. Collaborating with today's industry is important and necessary, of course, but blindly seeking private funding could limit our future potential.

–Do you mean that this objective should be put into context?

–Precisely. If our activity were simply focused on strengthening the industry of the present within the framework of contract research, we would be somehow wasting our research team's creative power, and our researchers might think of moving on. Had we had the need to obtain 30% of private funding from the very beginning, we might not have been in a position to found Graphenea, Simune, Ctech-nano, Evolgene, or Prospero.

–Can you give us an example of applied research that could be carried out at nanoGUNE?

–We have a very interesting industrial project with Intel. Intel funds part of our research in the field of spintronics, which is a field in which we are very well positioned internationally. They approached us; they came to Felix Casanova. That is our model. Intel is not funding us to improve their integrated circuits of the present; they are funding us, because they want to work with the best people in the world capable of designing and developing the technologies and the integrated circuits of the future, as this will allow them to still stay, in the future, at the forefront of technology. What will the integrated circuits of the future be? We don't know; they don't know either. But one possible option might well be based on spintronics; and in that field, in the field of spintronics, we are among the best.

–And they came across you.

–They want to work together with the very best in the field of spintronics, and they want to do it now. We're working in partnership with researchers in Berkeley and in Paris; and Intel is funding us for our researchers to work in this field under the supervision of Felix Casanova.

–So this is private funding.

–This is private funding and the industry of the future. We would like to have ten projects like this, but it's not easy. And, even so, we would hardly reach 30% private funding.

–One of the ways to connect with industry is technology transfer.

–How should a center like ours transfer knowledge and technology? In general, we need to keep an eye on the opportunities we might find in the realm of applications, so we can move to the application swiftly. We should do contract research with industry, and we should also file patents. When we think that the results of our research could be taken to market, we patent those results and then license them to companies for their commercial use. That, too, is technology transfer. But there is another type of technology transfer: the transfer of people. Here we train researchers; and some of those would go to industry, which is another contribution to the economic development of our society. And, then, our fourth contribution is based on the creation of new spin-off companies. It's not easy to bring our research, especially in the field of nanotechnology, into the industry of the present. It's difficult to do that worldwide, and even more so here with local companies. As it is not yet easy to find here companies in a position to take advantage of our research and our technology, what we do is create new companies. Taking this avenue for technology transfer is quite usual in the most advanced countries all over the world.

MANAGING THE PANDEMIC

In the spring of 2020, during the COVID-19 emergency situation, nanoGUNE's director, Txema Pitarke, sent out fourteen emails to all

the employees with instructions on how to proceed. The first message went out on March 11th and the last one on June 16th. The state of emergency came into force on March 15th through a royal decree that had been issued the previous day by the Spanish government. By then, Pitarke had already sent his first message.

–NanoGUNE, a center that had always operated 24/7, was closed for the first time in its history.

–We were obliged to shut down the building on the orders of Pedro Sanchez, Spain's prime minister. The royal decree for that passed on March 29th, it came into effect on the 30th, a Monday, and was in force until April 9th, Easter Thursday. The decree was issued at midnight on Sunday, and was effective immediately. When I wrote my email, the decree had not been published yet; but I had a draft. A few minor changes were made to the draft, but not many. I didn't want to close the center completely, I didn't want to turn the equipment off. We run some equipment online, and I wanted to make sure that people could keep working using those tools remotely. In order not to turn off the equipment, it was necessary to have one or two people in the building for maintenance, and that is what we did. In my email, I said we would shut the building down until April 9th, but not necessarily the equipment. The authorities created a rather chaotic situation: everything was being improvised, contradictory and incomplete messages were being sent all the time. I tried not to spread conflicting messages; I tried to be coherent.

–Did you get guidelines from the Basque government?

–Only indirectly. In mid-May, we had a BRTA steering-committee meeting. At that meeting, the vice-minister of technology, innovation, and competitiveness, Estibaliz Hernaez, asked how we were handling the situation; then, we all shared our own guidelines. Otherwise, everything came from Madrid. In fact, we returned to the old days. We had always been told that we have the highest degree of autonomy in Europe; but that is clearly not the case, and it is precisely in this kind of situations when that is put to the test. In Germany, for example, there was much greater autonomy, since each *Länder* set its own rules. Not

in Spain: there was a single command in Spain, everything was totally centralized. We have been told over and over again that for the virus there are no frontiers, no borders, which is the reason why the Spanish government insisted that the management of the situation had to be centralized, with the same rules and procedures for all provinces; but then the same thing should apply to the border in Hendaye. In fact, we should have shared the same guidelines all over Europe, and the situation should have then be managed within each region. However, things were done the other way round.

–At that time, nanoGUNE had people from 26 different countries worldwide. Where did they stay during the lockdown?

–Most of them stayed here, as many have built their lives here. My advice was to telework whenever possible; but they all had the possibility to come to nanoGUNE when needed (except during the period from March 30th to April 9th). It was up to each individual to decide whether coming in to the center was necessary in order to do their job.

–You maintained the structure.

–Group leaders had to make sure their group would keep functioning. At the beginning, some of the group leaders asked all members of their group to stay at home, while others were more flexible though still following strict safety measures, of course. I have always wanted to base everything on trust.

–Did you get any special requests or assignments in connection with the pandemic?

–There were a number of things. On the one hand, there were a few calls made, both here and in Madrid, for proposals on research projects aiming to combating the virus. One of our group leaders, Raul, submitted a proposal in answer to both calls, here and in Madrid; but his proposal was not selected for funding. It was a long-term project, the objective of which was to develop antivirals as inhibitors that would prevent the virus access to the cell. And then there was the issue of the PCRs. We have a couple of PCR tools, so we made them available from the very beginning. They can be used for genome

sequencing. We were accredited in Madrid together with Neiker, bioGUNE, Gaiker, and Tecnalia.

–How was the crisis managed, in your opinion?

–At the beginning at least, the Spanish government seemed to leave the most difficult decisions in the hands of the experts, which I think is not correct. It is important, of course, to take into account the advice and information offered by the experts; but based on the scientific evidence at hand, problems can usually be faced in various ways, depending on many factors, so the final decisions must be made by the authorities. It is the responsiblity of politicians, not scientists, to make this kind of decisions. And the Basque government? Well, at the beginning the Basque government couldn't do a lot; but, in my opinion, they did pretty well, the situation here seemed to be somehow under control. When the situation was critical, in spring, a number of mechanisms were put in place to deal with a potential collapse. I don't think the situation in the Basque Country went out of control[64].

–During the pandemic, the world of science gained particular relevance in the media.

–Pedro was everywhere in the media. He was arguing in favor of fundamental research and the idea that we need to be prepared for new unexpected situations that we might encounter in the future, and that is exactly what I think too. We are now facing a health crisis. Next time, who knows. No idea. We can't even imagine what is coming up in the future. The next crisis might be related to climate change, maybe, but we can't tell. We seem to be breaking nature's intrinsic balance, which inevitably leads to crises. Right now, health personnel seem to be the most important people in the world, but that's not necessarily the case. We are all important. Health personnel are, of course, particularly important, and they must be credited for the enormous effort they have made; but in the next crisis another sector might be in the spotlight. Our society must be prepared to face new, unexpected challenges. And which societies are capable of facing any forthcoming,

[64] This part of the interview took place in June 2020.

unknown crisis? Scientifically and technologically advanced societies. Only societies at the forefront of modern knowledge will be able to face unexpected situations.

–Are you thinking of any scientific discipline in particular?

–All of them. That is precisely why we need to support all kinds of fundamental research. We should not focus on a particular area simply because, at one particular moment, that area seems to be the most important one. We need to explore all fields.

THE ROLE OF SCIENCE

Pedro Miguel Etxenike was the most visible scientist in Basque media (newspapers, radio, and television) at the time of the pandemic. The Spanish media also requested his presence; among others, he was interviewed by renowned journalist Iñaki Gabilondo. His opinion became a point of reference during the crisis. He dives right into the subject as soon as it is mentioned, almost before the question is even asked.

–By January 10th 2020, the genome of the Wuhan virus had been sequenced, and within ten days hundreds of laboratories around the world had the information. That is open science. Nowadays, everybody understands that medicine requires research, applied research, the search for vaccines, and so on. But if this is not done with the necessary perspective, we run a risk: we may be able to deal with the problems we know well, but we can find ourselves empty-handed when it comes to the unknown problems of the future. In the opening lecture at nanoGUNE, Pitarke said that rushing to the summit of a mountain may distract you from the beauty of the surroundings. The idea is that applied research must be carried out, of course, and it should not be underestimated; but to believe that science must be limited to dealing with ongoing problems is not correct. Science works differently. We must do fundamental research. We need to find a good balance between fundamental research, applied research, and technological development. Since we don't know what's

coming next, we need to have a number of options at hand to be able to deal with new challenges that will arise.

–How do you achieve that?

–Look at the difference between cancer and AIDS. Nixon[65] invested billions of dollars in cancer research, hoping that, with that kind of focus, they would find a solution. They did not solve the problem, but a lot of fundamental research was carried out. So when AIDS arrived, we had many options, not in terms of vaccines, which have not been found because AIDS mutates (the coronavirus is nothing compared to AIDS), but in terms of medication. Therefore, since we don't know what lies ahead, we must have plenty of options to hand.

–The thing is that during the pandemic society has come knocking on scientists' doors. What is the role of science in a crisis like this?

–There are three distinct points to be made on the subject of science. One is the role of science itself. It's obvious that we're in a position to face challenges thanks to the science of the past; without the science of the past, we would have no scanners, no DNA, and no X-rays in the present. And, looking to the future, hope lies in basic science, in the vaccine; we must develop that area. However, a mistake could be made: basing everything on medicine without taking into account that the greatest advances in medicine have come from the fields of physics and chemistry. Koch's bacillus was found thanks to the use of optical lenses, and there are many similar examples. We need to carry out applied research in medicine, with high intensity, and we need to support the public health system; but it would be a mistake to focus solely on applied research.

–The second point?

–Society must be aware of the role played by science, which is not as Churchill said cynically: "Scientists should be on tap, not on top"[66];

[65] Richard Nixon, 37th president of the United States (1969-1974).
[66] Recounted by Randolph Churchill, Winston Churchill's son, in his 1965 book *Twenty-One Years*.

think of what happened at the Spanish parliament when they said, in their attempt to avoid responsibility: "Let there be science". And the third point is the following: it is true that, in the rush of time and in the face of anguish, science has to move on as quickly as possible; but no more than that: otherwise, it would not be science.

–The crisis has revealed other problems, too, which are not so closely related to science.

–What are society's greatest problems? One is health, and then there is water; and another one is energy. Energy is key, because the world is consuming more and more of it; and with this globalization, in which we all consume more and more, risks have accelerated. In other words, the balance of the natural world is in danger. In a different realm, the sociopolitical one, the rise of fundamentalism and intolerance is a sizeable problem too. And this, precisely, is not something that would improve with less science: the opposite is true. We need more science and education to overcome it.

–The crisis has shaken established forms of governance too.

–Should scientists participate in governance? Some people say that ministers should be scientists. Should the health minister be an expert in infectious diseases? And why not expert in Alzheimer's disease? Watch out! But I agree that scientists should be involved in governance somehow. Political decisions cannot go against scientific evidence, in the way Trump did when he forbade mentioning global warming in official documents. However, it would be a mistake to think that when we speak of the future we should be making scientific decisions instead of political decisions. That isn't right because the future is not determined; it is not a question of putting a formula into a computer and waiting for the machine to tell you what to do. Political decisions must be the result of vision and many other things that should never go against scientific evidence, because scientific evidence provides space for many different options. Science will not tell us, for example, how to distribute the human sacrifice that must be made in order to face up to an economic crisis. That demands other approaches.

–But scientists could be in the government, couldn't they? You were once a minister of the Basque government yourself.

–There's nothing wrong with scientists being in government. Scientists are used to extracting the essence from a complex problem. There must be all sorts of people in politics; it should not be the exclusive realm of lawyers and economists. But to think that scientists will make better decisions just because they are more rational is wrong. For example, a scientist aims at finding the truth; but a scientific truth is not reached by compromise or negotiatiation with others. In politics, reaching agreement is very important; not so in science. Einstein was asked: "What do you think about all these papers that have been published against relativity?" His answer was: "If they had been right, one paper would have been enough".

POST-DATA

In my years as a journalist, I have always enjoyed going into professional people's workplaces: the writer's office, the painter's or sculptor's workshop, the musician's studio… On my first visit to nanoGUNE, Txema Pitarke took me through the research laboratories and, amongst other things, he showed me the cleanroom. I only saw it from the outside, but in that place I found the spark I have always sought in the workplace: the spark that makes you feel at the heart of a certain discipline and offers you the *abc* to understand it, the spark that also adds an emotional dimension to your rational understanding.

Unfortunately, that day I did not have a recorder with me, because the purpose of the visit was to get to know the center; but right there, as I listened to the explanations, I found the incentive and the desire to tell the history, and the stories, of nanoGUNE.

It was later, in the course of the conversations, that I came to understand the connection between science and creativity. Andreas Berger, nanoGUNE's research director, drew a parallel between the endeavors of writers and scientists, as he said that in both cases the creative process is at the core of everything. The director-general Txema Pitarke made another assertion: "Cutting-edge research can only be done with... creativity!". And Pedro Etxenike resorted to poetry when he quoted Blake: "The whole universe is in a glass of wine, or in a blade of grass".

I must admit, however, that not every subject was as sweet and easy. NanoGUNE is a pioneering center, which was launched from scratch thanks to the dedicated efforts of a number of stakeholders and individuals. Talking about the process, several ups and downs were revealed: a variety of viewpoints, opinions, misunderstandings,

and even opposing interests. As a compiler of the various versions, I am particularly grateful to my interviewees for their sincerity and earnestness.

In my role as a mere observer, I see nanoGUNE at the crossroad of centrifugal and centripetal forces. On the one hand, and along the prevailing trend in the international academic landscape, young people with a research vocation are encouraged to continue their professional career abroad, and, at the same time, young researchers from other parts of the world are welcome here, at the center, for a given period of time. On the other hand, and this is where the centripetal force comes into play, a few experienced researchers are attracted to nanoGUNE from all over the world, offering them permanent positions in the science system here. NanoGUNE's activity is entirely international; but, at the same time, it was created here, in the Basque Country, where it has its place and its heart.

The Basque Country has just arrived into the world of science. The Elhuyar brothers' discovery of the chemical element tungsten in the 18th century, which they originally named as wolfram, remained an isolated event in the history of this country; an oddity, a rare diamond. We had to wait until the 20th century to have research centers and scientists of our own. Now, in the 21st century, the science train has a few stations here in the Basque Country, and one of them is nanoGUNE.

Elixabete Garmendia Lasa

PROFILES

JOSE MARIA PITARKE
PEDRO MIGUEL ETXENIKE

JOSE MARIA PITARKE

"AS SIMPLE AS THAT"

Txema[67] Pitarke (Bilbao, 1960) finished our conversation with this sentence: "As simple as that". As simply as that, and with the confidence of a scientist. On the way to that simplicity, however, the interviewee has led the interviewer along a variety of paths and shortcuts, uphill and downhill, marking, correcting, qualifying with extreme precision all kinds of details that only an exceptional memory can retain, with the ease of someone familiar to the red pen. Anyhow, the first scene of this profile is painted in a costumbrist style. This is about when Txema Pitarke was a pupil at the Piarists' school in Bilbao.

–The school was between Alameda Rekalde and Ajuriagerra streets, the latter known as Espartero Street at the time, and not far from La Salve Bridge. I lived on the other side of the river, next to Campo Volantin, on Fontecha Salazar Street, which is parallel to the street leading to the Artxanda funicular station. At primary school, we used to go on the school bus; but from the age of ten we were not allowed to take the bus, so we used to walk to school by crossing the river on a boat: 'el bote' in Spanish. Back then, in Bilbao we used to speak Spanish, not Basque: "Pasábamos en bote, por una peseta, con Txomin el botero"[68]. The same at school; there was no trace of Basque there.

Remembering his classmates, the list turns into a political rainbow.

[67] *Txema* is a short form of the given name *Jose Maria*. It comes from *sema*, which, after palatalization of the first 's', in Basque spelling is written *Txema*.

[68] "We used to cross the river by boat, for one peseta, with Txomin the boatman".

–One of my classmates was Javier Madrazo[69]; he was very discreet and quiet; I have a picture with him on Mount Anboto. Josu Muguruza[70] also went to the same school. I remember him very well; he was two years older than me; he was in third grade when I entered first grade at the age of four. Another pupil, who was in my same year but at another classs, was Leopoldo Barreda[71]; he was the same as he is now.

In his early years, things were not straightforward for Pitarke:

–When I was four, my teacher, Tere Borde, told my mother that she thought I was a bit slow. My mother was so upset! But the teacher soon changed her mind. As I learned so quickly to read and write, multiplication tables, and all that, I skipped third grade: I was sent from second to fourth grade. But my parents were warned that I would later need to repeat a grade "because of his age". Otherwise, I would have entered secondary school at the age of nine, which was not possible at the time: I had to be at least ten years old before the end of the calendar year entering secondary school. My grades? They were good, I always got A grades in math. I was not top of the class, but I was among the top ones. In class, we used to sit down according to our grades: the very top-ranking student would sit at the first desk in the first row, and the student with the lowest grades would be abandoned at the last desk of the last row. My performance was always excellent in math, physics, and grammar; also in geography. At the time, I didn't like literature so much. Now I do, and I really like history now; but not back then.

–What do you remember about Bilbao's landscape at the time?

–The Bilbao of my childhood was an industrial city, with cranes all along the river Nervion; it had its own special charm. From were

[69] Javier Madrazo (1960): general coordinator of the United Left-Greens party in the Basque Country (1995-2009), and minister of housing and social affairs of the Basque government (2001-2009).

[70] Josu Muguruza (1958-1989): elected member of the Spanish parliament for the Basque political party *Herri Batasuna*. He was assassinated at Alcala Hotel in Madrid in an attack claimed by the GAL paramilitary group.

[71] Leopoldo Barreda (1960): elected member of the Basque and Spanish parliaments for the conservative party *Partido Popular*.

I lived, near Campo Volantin, we saw ships being built nonstop at the *Euskalduna* shipyard. We used to play in that area, on the pier; on Alameda Mazarredo too, as, at that time, there were hardly any cars on the street. We used to play cops and robbers. We didn't have a TV at home; we used to go and watch television at a neighbor's house. When I was taken to the cinema for the first time, to watch *Pinocchio*, I came out crying; I was scared with the big screen, I was in shock! I was born in a family that was deeply rooted in Bilbao and the Basque Country; I inherited that tradition.

–What brought you to the Basque language?

– At home, we had a number of books written in Basque, *Peru Abarka*[72] and others; some of them belonged to my grandfather. And I used to see my father, in the 1960s, sitting there with Oñatibia's Basque learning method[73]. I used to speak Basque mainly with my grandmother. I used to go to Zeberio[74] with her for the weekend, and we always spoke Basque there.

–Was she your grandmother on your mother's side?

–Yes, Maria Goikouria Olabarri. She died in 1994, at the age of 95. She was born in 1899; my grandfather, in 1898. She was my mother's mother. A few years after my grandfather died, she came to live with us; that must have been in the early 1970s.

–Did you learn Basque with her?

–Mostly from her, old *hitano*[75] as well. My father didn't speak much Basque. We used to go to my grandmother's place in Zeberio quite often; everybody spoke Basque there. There were two country houses: the first one was *Etxebarri*, where my grandmother grew up, her brother lived there; and in the other house lived my grandmother's

[72] *Peru Abarka* (1802): written by Juan Antonio Mogel, it is taken to be the first Basque novel.
[73] Radiophonic method for learning Basque (1965) by Jon Oñatibia.
[74] Zeberio: village in the Basque region of Bizkaia.
[75] Familiar way of addressing a single person in Basque, which takes into account the listener's gender.

elder sister. I have a picture, from the 1970s, with my grandmother and her sister sitting together in front of the porch. My aunt used to spend endless hours sitting on the ground in a squatting position, mostly in the kitchen, by the fire. We used to call my grandparents 'aitite' and 'amama'; but our mother called her grandfather '*áitue*' and her grandmother 'ámandre', both with the accent on the first syllable. My grandmother's parents were from Dima[76].

When he talks about his family and ancestors, Pitarke speaks, without further notice, in the Basque dialect of the Arratia valley of Bizkaia. He built his mastery of the Basque language on that strong foundation.

OUTSIDER

It is 1977. Seventeen years old, the ideal age for initiation rites; for example, to make his debut as a traveler.

–We were four friends, and we bought a van between us, a Commer, for 25 000 pesetas. We traveled all over Europe for a month with that van in the summer of 1977. In the streets of Paris, we went around playing the *txistu*[77] to get some money, a *txapela*[78] in hand. At Montmartre, we met an interesting bearded young man in his twenties, Mark, from Baiona. Then, in Brussels, we tried to visit the so-called 'extrañados'[79], exiles, Mario Onaindia among them, who had just been released from prison thanks to the 1977 amnesty law passed by the Spanish parliament two years after Franco's death. But the very day we arrived in Brussels, on July 21st, they were making a clandestine appearance in Durango, with Telesforo Monzon, under the pretext of *Askatasunaren Ibilaldia*, the 'freedom walk', that took place

[76] Dima: village in the Basque region of Bizkaia.

[77] Txistu: traditional Basque three-hole flute.

[78] Txapela: Basque beret.

[79] Some of the Basque prisoners who were being released from prison, thanks to the Spanish 1977 amnesty, were exiled by the Spanish government to a number of European countries. Among them, there were the six prisoners that had been given at least one death penalty in the infamous Burgos military trials of 1970; five of those six prisoners were sent to Brussels.

throughout the Basque Country in the summer of that year. From Brussels, we went to Amsterdam, Copenhagen, Sweden, and Norway. On our way back, we went to Berlin driving through East Germany; but we visited West Berlin only, because to go to East Berlin you had to pay at the Brandenburg gate and money was scarce. What did we do in Berlin? We watched Charles Chaplin's *The Great Dictator*[80], in German! A few days later, in Austria, near Innsbruck, the van died on us and never started again. We all returned to the Basque Country as best as we could, hitchhiking and with very little money.

In the photographs from that trip, Pitarke has slightly long hair, in line with the fashion of the time. But it turns out that that modern, urbanite boy was also a *txistu* player.

–I learned to play the *txistu* with the renowned Boni Fernandez, who at the time was the director of the Bilbao city band of *txistu* players. I also learned to play a few other instruments, and I became member of a local *fanfare* band. I was a bit of an outsider.

–In what sense?

–I used to hang out with the traditional Basque music crowd in old town Bilbao, and then I would go to Pozas[81] with my other friends; they were rather posh. Back in the 70s, some people in Bilbao thought of the *txistu* and all that as an old-fashioned thing to be doing. I used to hang in both circles. The *fanfare* thing was kind of orthogonal.

–What do you mean by orthogonal?

–It's a mathematical concept, which also plays a role in quantum mechanics. Two curves are said to be orthogonal when they have perpendicular slopes at the point of intersection. In quantum mechanics, two physical states are said to be orthogonal when they have a scalar product equal to zero, in which case the projection of one onto the other is zero; they have zero overlap. That is the reason why we say two things are orthogonal when they have nothing to do with

[80] The film was banned in Spain until Franco died in 1975. It was released in Spain in 1976, but only later in the Basque Country.
[81] The official name of the street is *Licenciado Poza*.

each other. When I was 14 or 15, my crowd was pretty posh, and in that environment I was a bit of an outsider, because I did things that others didn't do.

–What is your taste in music?

–In general, what I like best is jazz. Classical music too, of course: Mendelssohn's and Max Bruch's violin concertos, Bach's violin and harpsichord sonatas, Beethoven's triple concerto for violin, piano, and cello… But, above all, jazz. Not too modern, not very traditional: artists like Miles Davis, Thelonious Monk, John Coltrane… When I was in the US, I took full advantage of the opportunity to listen to good live jazz. I was able to really enjoy jazz, as the offer over there was much broader than here. I had the opportunity to listen live to those jazz giants who had played with the likes of Charlie Parker and Duke Ellington: Max Roach, Dizzy Gillespie, Art Blakey… They're all dead now.

Otherwise, Pitarke is a film enthusiast and a keen mountaineer; he knows the Pyrenees well, and he has hiked in the Alps too. But he hates all the setup around alpine ski resorts, and also everything connected with football. And he has a peculiar interest: genealogy. Following the trail of his ancestors, he has been able to go more than a thousand years back, thereby making across certain curious, interesting discoveries.

THE VOCATION

–What did you want to become when you were a kid?

–At the beginning, I wanted to become an agricultural engineer. Then I changed my mind and I wanted to become an architect. Then a biologist. And when I was about to enter university I wanted to become a mathematician.

–So how did you end up choosing physics?

–At high school, just before going to university, we took a test, and the psychologist said to me: "You're good at math and physics; as you like both, I suggest you do physics. In physics you will have math, but

in mathematics you wouldn't have much physics". I listened to him, so I chose physics. I got it right; but I could have got it right with other choices too. Once, Physics Nobel laureate Heini Rohrer, who was a member of nanoGUNE's international advisory committee, gave a speech in San Sebastian to high-school students, and he gave them a piece of advice I liked very much: "Choose what you want; but once you choose, stick to it and do your best". The point is that normally there is not just one 'best option', there are many good options; but once you choose one, you should stick to it and do your best.

Pitarke took his five-years physics degree in 1977-1982, at the science faculty of the University of the Basque Country in Leioa. After graduation, his plans were to take his PhD and work in research.

–To me the priority was to do research, so as soon as I finished my degree I started to write a master thesis on theoretical physics. In 1984, I was told that a lecturer position would be opened up at the university; I applied, and on October 1st, at the age of 24, I started lecturing at the Leioa campus of the University of the Basque Country. I was interested in theoretical physics, general relativity, cosmology, high energies, all of that. At that time, I was fascinated with formalism. Etxenike was not here yet; he says he rescued me. Towards the end of 1986, when Etxenike came here, I changed my area of research completely to do my PhD with him.

–How did you meet?

–In 1986, Fernando Plazaola[82] joined us at the faculty of science, and he told me: "Etxenike is very good; he's in Cambridge now, but he'll be coming to the University of the Basque Country soon, to the petrochemistry faculty in San Sebastian; you might want to do your PhD thesis with him". I wrote him a letter, back then there was no email yet, asking whether I could do my PhD thesis under his supervision. He replied, very briefly, telling me that he was planning to come to Leioa soon, as he would be a member of the committee on Plazaola's

[82] Fernando Plazaola: professor of physics at the University of the Basque Country; he was vice-rector of research and he is now dean of the faculty of science and technology.

PhD defence. The defence was held on October 14th 1986. We spoke in the corridor that day; he gave me a few minutes and made me an offer. I told him that I was working in other areas already, and his answer, very much in his usual style, was: "You won't find anything better than this!".

As he tells the story, Pitarke can't help laughing at Etxenike's reaction.

–A couple of weeks later, I went to the Altza neighborhood in San Sebastian, to Etxenike's office at the faculty of petrochemistry, and he gave me a few notes on tunnel microscopy. He was assuming, without asking, that I had accepted his offer. Hardly a few weeks before, the Physics Nobel prize had been awarded to Gerd Binnig and Heinrich Rohrer for their design of the scanning tunneling microscope. As usual, Pedro was on the right track. I kept my university lecturer position in Leioa, and I used to come to San Sebastian occasionally. Pedro used to leave me basically on my own; but he would always give me the right advice at the right moment; he did not follow up on my work daily, weekly, or even monthly. Whenever I progessed significantly with new ideas or new results, I would come over to his office in San Sebastian for a discussion; the meetings used to be brief and to the point. I was Pedro's second PhD student in San Sebastian; the first one was Andres Arnau[83], who had started about a year earlier while Pedro was still in Cambridge.

–You submitted your PhD thesis in Basque and in English in 1990.

–To the best of my knowledge, it was the first PhD thesis submitted in Basque and in English; it was also the first PhD thesis submitted in English at the University of the Basque Country. A few theses had been submitted in Basque before, but always along with a Spanish version. I first wrote the thesis in Basque, and then I wrote it in English; but the English version was not simply a translation of the Basque version: both were written from scratch. The title was 'Tunneling spectroscopy and emission of electrons and photons in solids'. Nowadays, we often

[83] Andres Arnau: professor of physics at the University of the Basque Country.

hear that writing the PhD thesis in Basque is a waste of time, as we all do and publish research in English. I am convinced, however, that we must also write PhD theses in our own language, in Basque, as in doing so we will be contributing to the development and normalization of Basque as a communication tool in all possible contexts.

–Are we talking about Lizardi's famous '*noranahiko*'[84]?

–Precisely. I am very much in favor of writing PhD theses in Basque. The leading role that English plays in specialized communication should not stop us from taking care of specialized communication in Basque. For the Basque language to become normalized and to be alive, it is important that we use it in all registers. In Basque, as in other languages, specialized terminology needs to be developed, and when you write a PhD thesis in Basque you are developing that terminology. We need to be able to think and discuss in Basque in all areas of activity.

RESEARCH AND MANAGEMENT

–If you hadn't crossed paths with the nanoGUNE project, where do you think you would be now and what do you think you would be doing?

–I would be at university, immersed in my research. I am still full professor at the university, but part time. When I started the nanoGUNE project, I decided not to have my own research team here at the center. I would, of course, keep on doing my research, but without using nanoGUNE's human resources for that. I made that choice, because I was, and I still am, convinced that, as director-general, in order to protect, at any time, the interests of the center the most appropriate and effective thing would be for me not

[84] Jose Maria Agirre "Xabier Lizardi" (1897-1933): outstanding poet of the Basque Renaissance which took place before the 1936 Spanish civil war; in his book of poems 'Bihotz-begietan' ('In the heart and in the eyes') published in 1932, he wrote 'euskara hori noranahiko bihurtuz' ('making Basque fit for everywhere').

to have my own research team at the center. Furthermore, my vision was to launch a center that would go well beyond my own field of research. I am a theoretical physicist, my own research is not closely connected with industry. But with this center we wanted to have an impact on industry; we would be doing cutting-edge fundamental research, but that research should somehow reach industry. We would be doing mainly experimental research, so the research focus of the center would be well beyond my own theoretical work.

–Do you ever regret that?

–No, not at all! Besides, I keep on doing my own research, although with less intensity. I had never had the ambition to run a center like this, I had never even thought about it. I just wanted to keep on doing my research, with my PhD students and my international collaborations; but when the opportunity came to me, I thought it would be interesting to start something from scratch. It was an attractive challenge for me. I faced the challenge with pleasure, and now I'm more than happy about that decision.

–You must have developed management skills at nanoGUNE.

–In the world of research, one has the feeling sometimes that management is simply a burden and a nuisance, as it takes away research time, which is what you would usually like to do all the time. I think, however, that management is also interesting, particularly when you see that it enables us to go for new challenges. I feel at ease. You need to make decisions all the time, which puts a burden on your shoulders; but somebody has to do it. Not everybody will like the decisions we make; most probably, not everybody will like us either. Anyhow, I make the grade in management. I feel very fortunate to have had the opportunity to set up a new center from scratch and, also, for having been able to bring an excellent team of researchers and professionals to the center. Launching a new center from scratch has been a very attractive, enriching challenge for me.

–I have a feeling that running nanoGUNE and its start-up companies requires tremendous flexibility; mental flexibility, and flexibility to move all pieces.

–First of all, it's important to have self-confidence, which I have; and it's also important to know yourself fully and be aware of your abilities, limitations, strengths, and weaknesses. Fortunately, I'm good at that. Many people, however, are not good at it; they think they are at A, but it turns out that they are actually at B; they're not down to earth, and that can be problematic.

–Is it because they think they are more than they are, or the other way around?

–It can be either way. You need to know where you stand. The worst thing that can happen is to want to be at least as good as your neighbor; envy is very bad, and unfortunately very common too. I don't have that problem. I'll always try to be the best, I'm competitive, no doubts about that. But not because I want to get what other people have, that's not the point.

–You are really ambitious.

–Yes, of course I am! But not necessarily because I would like to simply achieve what other people have. I am ambitious, because I would like to reach what I think I can attain. I like pursuing objectives, projects, goals; above all, I have immense intellectual curiosity, a scientist's curiosity. Setting goals is important; not only at work, also at the personal level, in everyday life; but not simply because we would like to achieve what others have. Once, in a recording about Etxenike, I said in Basque: "Pedro bakarra da"[85]. He liked it. And it is quite true: he is indeed unique. I could well think: Pedro is there, I am the director here, why couldn't I have the level of recognition he has? And the answer is: that's impossible, I'll never get that degree of recognition.

[85] "Pedro is unique".

–You don't try to imitate him.

–Not at all! Pedro has many qualities that I don't have; we have different personalities. One always learns, of course, instinctively from somebody like him, just by being close to him; but the main thing is to know where we stand, be aware of where we belong.

At this juncture, Etxenike makes his point about Pitarke's personality as a researcher.

–His successful career in management has not stopped him from keeping on doing research with very high impact. Pitarke is an outstanding researcher; he has three key attributes: the capacity to analyze his research subjects in depth, extraordinary skills in mathematics, and unusual physics intuition. Besides, he has an immense capacity for work. All of that allowed him to deliver an outstanding PhD thesis –he was awarded the special prize for best PhD thesis of the year– and to then keep on carrying out research of very high impact in condensed matter physics and quantum many-body theory, opening, in particular, new avenues in the field of collective excitations in two-dimensional systems. At nanoGUNE, he has kept on publishing research papers of very high impact, with his prediction, for example, of the existence of acoustic plasmons in graphene and his pioneering research on van-der-Waals interactions. And in 2009, he received a special mention from the jury of the 9th Manuel Laborde Werlinden prize for his business initiative on graphene.

THE BASQUE-SCIENCE BINOMIAL

Txema Pitarke has been the president of the Elhuyar Foundation since 2013, which reflects his commitment to the modernization and visibility of the Basque language. In that area, his work started at the Labayru Foundation, first as a student and then as a teacher.

–In the 1970s, the Labayru Foundation started to organize Basque literacy summer courses for Basque speakers at the seminary in Derio. It was a five-years program, which I took part in from 1977 to 1981. Right after I finished the last year, while still a physics undergraduate at university, I was hired to teach syntax and verbs. This led to the

publication of a book on verbs, based on my notes, which is still in print, I think.

Towards the end of the 1970s, Basque was struggling to get into the university and did so thanks to the initiative of a few young lecturers.

–When I started as an undergraduate at the university, in 1977, right after the official classes in Spanish, we took an extracurricular one-hour course in Basque every day, from one o'clock to two o'clock. Basque-speaking undergraduates from all science majors were there together in the same group. One of my classmates from biology was Iñako Perez-Iglesias, who went on to become rector of the University of the Basque Country. One day we would do physics with Jose Ramon Etxebarria, the next day chemistry with Jazinto Iturbe, and then it would be math with Jesus Arregi. Jesus Mari Txurruka taught biology; but we physics students only took physics, chemistry, and math. Official lectures in Basque were incorporated in the first-year science syllabus later, during the 1979-1980 academic year.

In that framework, it was urgent to publish textbooks in Basque. Pitarke took an active part in the preparation of teaching material and books. In addition to his participation, in the 1980s, in the publication of a number of textbooks, he was also active in science popularization in Basque with his publication, for example, of the book *Akerraren Fisika* (Elkar, 1983), together with other members of the physics department at the Basque Summer University[86], all led by Jose Ramon Etxebarria.

–Our goal was to explain to nonexperts a few extraordinary aspects of the behavior of the universe, by telling the adventures of the great magician Merlin. Merlin does magic, and through his magic we unveil some of the most extraordinary and incredible physical phenomena, such as, for instance, quantum tunneling, according to which particles, for example electrons, can tunnel to the other side of a potential barrier. And all that in the framework of a so-called *Akelarre*, a witches' Sabbath where Merlin took part in, together with

[86] Udako Euskal Unibertsitatea (UEU).

the witches and a billy goat, *akerra* in Basque, which is where the title of the book comes from: *Akerraren Fisika*[87].

Pitarke's involvement with the Basque-Science binomial includes his teaching activity at the Basque Summer University (1982-1992), where he was later in charge of the department of physics during the 1990s. And this involvement brought him a few prizes, such as the Azkue and Zumalabe research awards in 1990 and 1991, respectively.

–As you were teaching, writing, and broadcasting science in Basque, you came across Elhuyar.

–I always had a relationship with Elhuyar. At the beginning of the 1990s, I published a few research articles in the original *Elhuyar* journal, thereby demonstrating that it was possible to write cutting-edge research in Basque. That research journal was later replaced by a popular-science magazine, *Elhuyar Zientzia eta Teknologia*, where I have been writing on a regular basis. I also published an article in 2009, together with Igor Campillo, in *Elhuyar Hiztegi Enziklopedikoa*[88] on nanoscience and nanotechnology. I took part over several years in the CAF-Elhuyar awards jury, and, in the framework of the opening of nanoGUNE in 2009, journalist Manex Urruzola interviewed me on the *Teknopolis*[89] TV program.

–As president of the Elhuyar foundation, what are your duties and responsibilities?

–That depends to a large extent on the president. Here I agree with Pedro: the executive person working day-by-day should be allowed to do their job. I, as president, am involved in networking and in our relationship with institutions, and I take care of the board of trustees. The board needs to approve the director's management and performance, and, in that regard, the point of reference is the president.

[87] *Akerraren Fisika*: *Physics of the billy goat.*
[88] *Elhuyar Hiztegi Entziklopedikoa: Elhuyar Encyclopedic Dictionary.*
[89] *Teknopolis* is a science-popularization TV program produced by Elhuyar for the Basque public television.

–Was there ever any trouble?

–Well, yes, there was indeed. When I took over the presidency in 2013, in times of crisis, for two or three consecutive years our economic outcome was negative; the project was at risk, and I had to go into the accounts a bit. We had considerable losses, which we had to recover over the following years. At that time, Elhuyar's director was Leire Cancio; she handled the situation very well, so my job was easy. When the director is good, the president's job is always easy. We had other problems too, but Leire faced them with courage and good judgement. The current director, Jon Abril, is excellent too.

THE ENGLISH-SPEAKING WORLD

The influence of English-speaking culture on Pitarke is quite remarkable. This is not a surprise, as he has spent a great deal of time in the English-speaking world, fully immersed in his research activity. During the period 1989-2003, he spent long years at a number of universities and research laboratories in the US, where he worked with renowned scientists of the stature of Rufus Ritchie and John Perdew, among others. In the 90s, he spent a few terms at Imperial College in London UK, and later on he visited, for a few months, Cardiff, Cambridge, and Griffith University in Queensland, Australia. Just before launching nanoGUNE, he was a Visiting by-Fellow at Churchill College and the Cavendish Laboratory in Cambridge.

–I have heard, at some point, Etxenike talking about Lord Pitarke.

–Ha-ha-ha... There is no doubt that the English-speaking world has somehow influenced me and my work. In research, I follow, to a large extent, the English-speaking model. My personality might also be influenced by that world: methodic, phlegmatic… What does it mean to be phlegmatic? "I've just learned, on a Friday, that my factory burned down. Good Lord! How upset I'll be on Monday!".

–The stiff upper lip of the English?

–In England and in the UK, in general, I feel at ease. Also in the US, especially in research: the US is a point of reference for me there.

Life in the US, however, is a bit unfamiliar to me; in that regard, I prefer Europe.

–What puts you off the most in the US?

–There is an emblematic film with James Dean in it, *Rebel without a cause*, about the American dream, which portrays American society in the 50s very well. People are, in general, very proud of the dream of everybody having the same opportunities to get ahead in business and in all part of life. But in that false dream things may end up being like a plughole in a sink: once you enter the whirlpool, it is impossible to escape. That is exactly what happens to many people in the US, I think; more than in Europe. If you don't have a car, for example, you can't survive, you can't get out of the whirlpool, as you can't even go looking for a job! There is hardly any public transport. How can that be? When I was at Oak Ridge National Laboratory[90] in Tennessee, there was not a single bus or train to go from town to ORNL. The laboratory is about 15 kilometers from Oak Ridge downtown, but there was no public transport! And it is not a small laboratory: about five-thousand people are on the payroll, and they receive around three-thousand visiting scientists every year. But you can only reach the laboratory by car.

–Road-movie style…

–Exactly. In general, there are no streets, no sidewalks. There are in Manhattan, of course, and in a few other big cities; but in most places there are just huge highways. Almost everything is done without getting out of the car, and people meet mainly in malls, those large enclosed shopping areas with no traffic inside. When I arrived in the US for the first time, in 1989, that was all new to me, it was the first time I saw a mall! At the time, there was nothing like that in Europe, I think. I know the US pretty well, because I crossed it from northwest to southeast: more than three-thousand kilometers. I did that in the 90s. It was pretty much all the same. Like in the Cohen Brothers' films,

[90] In the period 1989-1994, Pitarke spent several terms in Oak Ridge.

Fargo and the like. Manhattan is different: I wouldn't mind spending a couple of years there.

–And England?

–In general I like it, although I must say it looks a bit archaic in some rural areas outside the main cities. London, I like a lot; but outside London… In some towns and villages, one has the feeling of going a few years back in time. It used to be like that; now I don't know.

THROUGH A PHYSICIST'S EYES

–Does physics give you a particular perspective on the world?

–All professions do that; there's no doubt that people are somehow shaped by their profession. I would say that a scientist's profession is a bit like that of a pianist or a writer. Newton, for example, used to say that his research was constantly before him. His exact words were: "I keep the subject of my inquiry constantly before me". Niels Bohr also said something like that when he was asked about his years-long, extraordinary contribution to the development of quantum mechanics; and when he was asked about his exceptional intuition, he replied: "If you had an idea how hard I worked in my early years, how I calculated and recalculated, then you would understand that later one can easily arrive at a result by intuition". And the same happens to us, to some extent: we spend so much time thinking and rethinking, going round and round, over and over again!

–So those dynamics give you a different way of looking at the world?

–That could well be. Physics is the study of natural phenomena; we are committed to understanding the universe, as we scientists are convinced that natural phenomena are, in fact, comprehensible, that we can discover the fundamental laws that govern the behavior of nature, and that making use of those laws can enable us to make predictions. There's no reason to believe this should be the case, but nature does seem to be working that way. We scientists are committed to describing somehow the things we cannot see directly with our

eyes. We can hardly see galaxies, and atoms are too small. So we need artificial eyes: telescopes, microscopes, or particle accelerators, for example. And then we need to understand and interpret the kind of things those eyes show us. Physics is, after all, based on the description of the universe and the study of natural phenomena.

–That's it! Do you think the description of the universe could be somehow related to transcendence?

–Mmm… I'm not so sure about that. Do you mean by transcendence the kind of things that lay beyond our world, beyond our lives, beyond our reach?

–The eternal question. Do you think that a 'beyond' could exist?

–I am afraid that's a question with no answer to it. At least, it's a question that can't be answered by a physicist in the framework of science. Why should we search for something that cannot possibly be reached or found? That's like banging your head against a wall over and over again. I'm interested in questions with an answer, however difficult it might be to find it. I'm interested in being able to at least get closer and closer to the solution, even if I know I'll never reach it entirely. If something, for example God's existence, is beyond my reach, I'm not interested. I don't know whether there is a God; it's a question with no answer. The origin of the universe took place nearly fourteen thousand million years ago. I've been asked many times: "What was there before that?". That 'before' simply does not exist; there was no time and there was no space, so you cannot possibly ask that question. It's not a well-formulated question; it is a wrong question with no answer, a question that makes no sense. As simple as that.

PEDRO MIGUEL ETXENIKE

HUMAN TOUCH + SCIENCE

He confesses his weaknesses without difficulty. For example, not having musical skills. He realized that at the Capuchins' high school in Lekaroz, where his father and grandfather also went. Composer Aita Donostia, the musicologist Jorge Riezu, and *txistu* master Hilario Olazaran set up one of the most outstanding Basque-music laboratories there. Etxenike found out, however, that he had no future in that discipline.

–I like music, but I can't hold a note! Otherwise, I would have tried to become a *bertsolari*[91]. My wife, who has a degree in piano, and my two daughters laugh at my incompetence. I met musicians in Lekaroz, but I was never in the choir or anything like that. I don't have a single musical bone in my body.

Another weakness, which is one of the big regrets of his life, is that he did not go further with biology.

–I should have studied more biology. Biology is one of the major disciplines of knowledge; within biology lies life, and within life lies consciousness. I don't understand much about the world of neurology, for example; I've read a lot, but I lack basic training. So I'd like to know more about biology in order to be able to follow the great developments of the 20th century, DNA and all that. That's why I regret not having learnt more about biology systematically.

Etxenike's CV is like a book, with over 170 pages that include his academic career, scholarships, books and other publications, lectures he has given around the world, seminars and conferences he has attended, doctoral theses he has supervised, research projects, research positions, awards and honors… Here are three quick examples to

[91] *Bertsolari*: Basque verse improviser.

illustrate that: he was a member of the Trilateral Commission[92] (1996-2015); he has been an honorary member of the European Physical Society[93] since 2018; and he was the founder and first president (2007-2012) of Jakiunde[94], where he is now honorary president.

As for the awards he has received, his *Annus Mirabilis*, as he puts it, was 1998, when he received the Prince of Asturias Award for research and technology, the Max Planck Prize for physics, the Golden Medal of the University of the Basque Country… And that very year he was named *Seme Kuttun*, 'Beloved Son', of Izaba, his hometown.

–Only two of us have been named *Seme Kuttun* in a century. The other one is Angel Gale, a businessman who built Izaba's fountain and hotel and also the fairground and funicular in Igeldo[95]. I am very happy to have been honored along with him.

Izaba is still his original point of reference; he goes there often, to his shared family home.

IDENTITY / IDENTITIES

Pedro Miguel Etxenike was born in the Basque Pyrenees, in 1950, in a little village called Izaba, where his father was the doctor. His father, Pedro Etxenike Iparragirre, was originally from Irurita in the Baztan valley; his mother, Felisa Landiribar Cenoz, was a school teacher from the valley of Ultzama. His father was a nationalist, and his mother was fond of Basque culture and language. When asked how he came into the world of Basque language, he goes deep:

[92] Trilateral Commission: non-governmental discussion group made up of renowned individuals from North America, Europe, and Asia to foster political and economic dialogue around the world.

[93] European Physical Society: it brings together 40 physics associations and has 120 000 members; there are 21 honorary members, of whom 7 are Nobel laureates.

[94] Jakiunde: the Basque academy of science, arts, and humanities.

[95] Igeldo: quarter of San Sebastian, located at the mountain range of the same name towering over the west side of the bay of *La Concha*.

–I am a Basque nationalist, in my heart and through family tradition. We all anchor our identity to different things, which don't have to be incompatible with each other or with other things. Being part of something doesn't prevent you from also being part of other, larger things. The other day, as I couldn't sleep, I watched a documentary interview with Maialen Lujanbio, the verse improviser. Her final verse was on the subject of fire: "*Sua da bi begiradek sortzen dutena*"[96]. So wonderful! But I am similarly moved when I hear Phil Anderson speak about emergent properties. What I mean is that I have parts of me which connect with Harvard and Cambridge, while other parts of me connect with Basque verse improvisers.

–A major part of your education took place in English-speaking countries; that's something you often claim.

–I don't claim that, I point it out. There are different traditions: the French tradition, which is Jacobin, more deductive, traditional; and the English-speaking tradition, which is more empirical and based on trial and error. Only the Catholic Church is older than the universities. The University of Cambridge celebrated its 800th anniversary in 2009; it must have done something right to survive throughout the ages. And in the academic world the English-speaking model has been the most successful one. However, everyone is entitled to their own opinion. In surveys, Harvard University is often listed as the best university in the world; but if you talk to the experts, Cambridge often comes out on top. I always wanted to go to Cambridge. The electron, the neutron, and the DNA's double-helix structure were all discovered at the Cavendish Laboratory in Cambridge. The Cavendish was opened under the direction of Maxwell[97]. Maxwell's equations justify three hundred years of basic research; they codify electricity and magnetism. I have written on Maxwell's own desk, it was so thrilling! I fell in love with Cambridge. Afterwards, I went to places that follow the English-speaking model, such as Lund, in Sweden, and Copenhagen. I went to Barcelona too. And after I finished my time at the Basque government,

[96] "Fire sparks from our looking into each other's eyes".
[97] James Clerk Maxwell (1831-1879): scottish scientist, father of electromagnetism.

I returned to the Cavendish and Churchill College, both in Cambridge. I became Overseas Fellow there; a few years later, Anderson himself was named Overseas Fellow. At the time I was there, Ken Arrow[98] was Overseas Fellow in the field of economics. After that period, I came back here to set up a research group. Ever since, my goal has always been to do here what I learned in Cambridge.

Like many others of his generation, Etxenike started his political activism at the time of the infamous Burgos military trials of 1970. Back then, he was studying physics at the University of Navarre, where he enrolled in the academic year 1967-1968, first in Pamplona in a course common to engineering, architecture, and physics students, and then in San Sebastian[99] focusing on physics.

–We forced the University of Navarre to go on strike to protest against the Burgos military trials. The students' deputy spokesperson was Antxon Santamaria, the son of Carlos Santamaria, and I was the spokesperson. Students who were involved in politics more than me thought that, if we were going on strike, the spokesperson should be the one with the best academic record. And that's how they chose me. A so-called Basque Culture Group (EKT - *Euskal Kultur Taldea*) was also active in our faculty.

Etxenike's journey into the Basque language is typical of the period. He started at the EUTG[100] center of the University of Deusto in San Sebastian, where he took his first Basque lessons using Patxi Altuna's[101] pioneering method. His teacher was Mikel Arregi, who would later become a renowned poet. Among his classmates, he remembers the wife of the harp player Nicanor Zabaleta, Graciella Torres, from Puerto Rico. Etxenike was familiar with Puerto Rico as his uncle, Miguel Etxenike[102], and his wife, singer Vilna Gaztambide, used to live there.

98 Kenneth Arrow: Economics Nobel Laureate (1972).

99 In the building that is now hosting the Koldo Mitxelena arts center.

100 EUTG: *Estudios Técnicos y Universitarios de Gipuzkoa* - Technical and University Studies of Gipuzkoa.

101 Patxi Altuna: Basque linguist and author of the *Euskara, hire laguna!* Basque language method.

102 Miguel Etxenike: promoter of Puerto Rico's economic policy.

–In the summer, I took a Basque intensive course for 30 days, 11 hours a day, in the Augustinians' convent in Oñati. Koko Abeberry, Jakes Abeberry's brother, both of them from Enbata[103], and Patxi Ormazabal were students there as well. I had two great teachers, Juanjo Uranga and Eusebio Osa. I learned to speak Basque pretty well. I also stayed at Pako Garmendia's house in Azpeitia; I talked a lot to his sisters. I used to go to a farmhouse called Azautza, where I met an almost-blind elderly man whose name was Batiste. I became fond of verse improvising there.

–You must have been one of the first to mix Basque verse improvising, *bertsolaritza*, with science.

–I still remember by heart the verses I read in Xalbador's *Odolaren mintzoa*[104]. I've always thought that Basque verse improvisers have a synthetic mode of transmitting ideas, of saying things, which is very useful in the field of science. In my lectures, I try to synthesize concepts in a very precise manner, in the same way the Basque verse improvisers do; for example, when Andoni Egaña sings: "*Zu lanean lo egoten zara; ni, berriz, lotan lanean*"[105]. What a great way of communicating concepts and ideas! I have always been keen on the Basque language, and I'm astonished to see how some people still reject it. If only for the sake of scientific ecology, Europe should venerate Basque. We are concerned about the extinction of species, but how about languages?

–You had a close relationship with linguist Koldo Mitxelena.

–Koldo used to go to the Roncal valley to study the Basque dialect that, at the time, was still spoken there. My father used to put him up. Juan San Martin and others used to go too. One day, in 1971 or so, Mitxelena asked me whether I could go with him on a hike in the hills to study the toponymy there. Joan Coromines, the well-known

[103] Enbata: political movement in the continental Basque Country.
[104] *Odolaren mintzoa* - The speech of blood (Auspoa, 1976), a collection of verses by Fernando Aire "Xalbador".
[105] "You're often asleep at work; I, however, work while I sleep".

Catalan linguist, came along with him, and I became their guide. After a few hours, I left them with the forest ranger and went down to Izaba to play cards. Suddenly, a man ran into the bar shouting: "Pedro Miguel, Koldo has broken his knee!". My father had something like a stretcher, and we carried it up the mountain to rescue Mitxelena[106].

–The knee was broken, but your relationship was intact.

–He invited me to go to Salamanca, where he used to live, and I became good friends with his wife Matilde[107]. I suspect, although I don't know for sure, because I was in Barcelona at the time, that Mitxelena gave my name to Garaikoetxea when he was about to form the very first Basque government after Franco's dictatorship. I had published an article in *Deia*[108] in 1979 making the case for a Basque university with a strong research arm. Maybe that's why Mitxelena gave him my name.

And so in 1980, when forming his government, president Garaikoetxea called Etxenike to become minister of education. From 1982, Etxenike also served as minister of culture and as spokeperson of the government. Afterwards, he returned, as visiting professor, to the Cavendish Laboratory in Cambridge. Etxenike expresses his sincere gratitude to those who made it possible for him to study there:

–Doing a PhD in Cambridge provides you with many opportunities, not only to study your own subjects, but also more general subjects. In Cambridge, I took a number of courses from other fields, which came in very handy throughout life. I had good grants, one from the Juan March Foundation, and another from the Aristrain Foundation, which I got thanks to the good offices of Pako Garmendia. I have always been grateful to those two foundations.

[106] The accident happened on Mount Ezkaurre.
[107] Matilde Martinez de Ilarduya.
[108] *Deia*: Basque nationalist newspaper founded in 1977.

UNPREDESTINED PHYSICIST

–Why did you choose physics?

–When I was at high school, I got A grades at everything except for the *Formación del Espíritu Nacional*[109] and Physical Education. I liked everything; but when I had to do some work on literature, an essay, for example, I never knew whether I had done well or not. However, when it came to solving a mathematics or a physics problem, I knew right away whether my answer was correct. So, going against commonly held beliefs, I would say that, for me at least, sciences were easier than humanities. In humanities, especially at the beginning, you need some contextual knowledge to understand things, which you may have or may not have; but problems in mathematics, in algebra, for example, are so transparent that if you understand them you don't have to study at all. I used to get A grades in algebra throughout my whole degree without ever having to study at all, because once you understand it, it's really easy. That didn't happen to me in history or in philosophy; they seemed more difficult to me. The periodic table and those things were wonderful, because everything fell into place, especially with mathematics. Once I finished high school, in my first year at university I did sciences. I didn't like engineering so much, nor technical drawing; I was very bad at drawing. I studied algebra, calculus, physics, chemistry, and biology, and since you could do physics in San Sebastian, I ended up going there.

–When you say it like that, you break the spell a bit.

–I'm not someone predestined by God, who was visited by the Holy Spirit and told: "You shall be like Newton!". It is true, however, that the more you understand a subject the better you like it. And I've always thought physics was a great degree to study, because it helps you understand nature. It gives you mental structures for analysis and for getting to the core of complex problems, which can be useful for

[109] *Formación del Espíritu Nacional*: National-Spirit Education. During Franco's regime, it was a core course at high school, which was usually taught by members of the Spanish fascist political organization *Falange*.

other professions too. For the same reason, it seems right to me that there should be physicists in politics; politics shouldn't be the exclusive realm of lawyers, economists, or teachers.

–Does physics provide a particular vision of the world and the universe?

–Physics helps you understand what things are made of and why they are the way they are. If you understand things, physics is helpful for developing a good mental structure. Science is of enormous beauty; I mean inner beauty, structural beauty, not just the beauty of images. If I were extraordinarily rich and able to gift my daughters long years of education, I would advise them to study physics and mathematics, philosophy and history too, the history of ideas, because the rationalism of physics is not the only human rationalism. I like everything. After all, I am a kind of a smuggler who likes going down many different paths: some familiar ones, others not so much. You can return to the path whenever you want; but "*bidezidorrak ere ebaki behar dira*"[110].

–You're not afraid of getting lost?

–No! Thank goodness! We should all get lost sometimes…

–You don't get vertigo?

–Not at all! You can't feel as if you were a Newton either. Sometimes you might think, "I'm so smart!". But you only need to read what Newton did in eighteen months to realize that you're nothing. You read Einstein or Anderson and it's about the same. If I regret something, now that my life is getting shorter and shorter, it is the fact that I won't have enough time to understand so many things I would like to know. And that's such a pity!

–Too many questions are left with no answer.

–The greatest advance of knowledge is to expand ignorance, because unconscious ignorance becomes conscious. The more you know, the

[110] "One also needs to walk on the shortcuts".

more things are left to be discovered, and that is an inexhaustible source. That's why it is so absurd not to invest in education, science, and technology. Education is the seed of the future. No tribe in the world, not even the most primitive one, eats the seed to be sown, even when they are hungry.

–And that hunger to explore the universe...

–The universe, following Blake[111], is in a glass of wine. There are molecules in a glass of wine. And how did those molecules come into being? At first, there was only energy, and atoms were the first thing to come into being. It took 300 000 years after the Big Bang for many atoms to form. Then they evolved; others were the result of supernova explosions; and then we had molecules, which combined to form a flower or wine or consciousness. So, yes, the universe is in a glass of wine or a blade of grass. Understanding that is something of beauty. The fundamental elements of matter are few, but the world of things is inexhaustible.

–Does meandering around these realms lead you to transcendence?

–Uh-huh! Transcendence! Not necessarily, but not the rejection of transcendence either. After all, scientists are people who come from certain traditions. More people used to worry about transcendence in the past. Newton believed in God, and he was the greatest scientific talent of all times. Einstein was a man of faith too, but in Spinoza's sense, which is to say that he believed in the order of the universe, in a universal pantheism. Among elite scientists, defined as the members of the academies of developed countries (which, by the way, is a curious definition), the number of believers is diminishing considerably. But there are still some of them, like Hewish[112], who says: "We don't know the orbit of the electron, which is affected by the fluctuations of a void we cannot measure; how can we possibly know many other things?". Or the cosmologist Martin Rees[113], who says: "I practice religion, but

[111] William Blake (1757-1827): poet and artist.
[112] Anthony Hewish (1924): Physics Nobel Laureate (1974).
[113] Martin Rees (1924): British astronomer.

I don't believe in God". He likes the liturgy, the social side of it. Many people would say: "I believe in God, but I don't practice". Rees says the opposite.

–So there is no taboo in either sense.

–The journalist Iñaki Gabilondo asked me questions about transcendence in an interview[114] at the Cesar Manrique Foundation. Towards the end, half-jokingly and half-seriously, I told him: "Only physicists talk about God nowadays". There is a much greater tendency among physicists than among biologists to talk about God. When one looks at the original singularity, the beauty of the universe, the beginning, the Big Bang, you could well think: "What was there before the Big Bang?". In physics, that question doesn't make much sense, because matter is connected to time; but I've often said that only physicists talk about God. Bishops talk about funding Christian schools and about the unity of Spain as a 'moral good', which is what cardinal Cañizares said recently. Can you imagine what would have happened if bishop Setien[115] had talked about the unity of the Basque Country as a moral good?

–By the way, how does somebody from Izaba who is living in San Sebastian deal with the Basque/Navarre binomial?

–I get angry when I hear "Bildu got five seats in parliament, four representing Euskadi and one representing Navarre" on Basque television. Mitxelena once said: "*Edozein erakunde politikoren gainetik, badago harako Zazpiak Bat hura, Sabinok behin-behingoz Euzkadi izendatu zuen elkartea*"[116]. There is a political will to unify something that already exists culturally, which is *Euskal Herria*: Basqueland in Basque. The misunderstanding arose along with the

[114] The interview took place on July 9th 2019.

[115] Jose Maria Setien: bishop of the Diocese of San Sebastian (1979-2000).

[116] "Above any political institution there is the *Zazpiak Bat*, that entity Sabino Arana called *Euzkadi*". *Zazpiak Bat* means *Seven Provinces* in Basque, the seven provinces that form the Basque Country, which Sabino Arana called *Euzkadi*, currently spelled *Euskadi*. Sabino Arana (Bilbao, 1865-1903) was a Basque writer and the founder of the Basque Nationalist Party.

Statute of Autonomy, in which three Basque provinces were to make up the so-called 'Basque Autonomous Community' or 'Autonomous Community of Euskadi'; but it is wrong to use the word Euskadi to refer to only three of the seven historical Basque territories. I have said many times that our will is to see how the historical *Euskal Herria* becomes a political entity called *Euskadi*, thus strengthening the bonds between the seven provinces, with pragmatism and firmness. I would never say Euskadi and Navarre; I say Basque Autonomous Community and Navarre. We should, at least, respect the name of the political concept which Sabino Arana drew up.

COCKTAIL OF BOOKS

In Etxenike's office at the DIPC there is a fairly large desk at the back loaded with books. He's in the process of reading a few of them; others he uses as reference material for preparing speeches or writing articles, and to extract quotes as he is a compulsive collector of quotations. He often adorns his speeches with citations he finds in many places and in three languages: Basque, Spanish, and English.

–I've always enjoyed reading. We used to read a lot in Izaba. When I was a kid, there was no television, and we used to read comic books: *Capitan Trueno, El Jabato, El Guerrero del Antifaz, Roberto Alcázar y Pedrín*, and a lot of novels: the entire *Sandokan* series by Emilio Salgari, and Dicken's *David Copperfield*, which made me cry because it was so sad. I've read many novels in the course of my life, and now I read more essays. I like to reread things too, like, for example, Rita Montalcini's *In Praise of Imperfection*. She was a marvel, that Italian woman. When she was young, she watched a house servant die, which led her to study medicine. She was awarded the Nobel prize in 1986, and she died at the age of 103. It's a wonderful story. We can look at what's on my table, if you'd like to.

–Wonderful!

–*Grandes errores de la ciencia* (Mario Livio); *Birds and Frogs* (Freeman Dyson); *Identity: Contemporary Identity Politics and the Struggle for Recognition*, by Francis Fukuyama, which is about the

value of identity; *Defensa del lenguaje* (Pedro Salinas), which I will use for my laudatio to Alberto Galindo[117]; *El misterio de la creación artística* (Stefan Zweig): how certain geniuses do the very same things, but in very different ways. Lope de Vega used to write a play per week or every month, while Goethe started *Faust* at the age of 18 and finished it when he was 82. This is a wonderful book, *Truth and Beauty: Aesthetics and Motivation in Science*, by Subrahmanyan Chandrasekhar; one of the chapters is about the creativity of Newton, Shakespeare, and Beethoven. This one, *21 lecciones para el siglo XXI*, by Yuval Noah Harari, is about how the world has changed for better, despite the current catastrophism.

–I see that in the books you underline texts that interest you.

–Yes, and sometimes I write quotes down in this notebook. The quotations I use in my lectures and talks are always quotes I've read; I don't take them from quotation collections. This one, for example: "The struggle for economic resources will take place between generations"; I took it from Jose Ignacio Latorre's book *Ética para máquinas*.

–That quote sends shivers down my spine.

–Science has helped humankind a lot; but it's also brought trouble. I would mention three basic problems. One is the potential climate change; we have been inexplicably insensitive to this problem. Another one is the issue of nuclear weapons; but that is getting better, because twenty years ago there were 56 000 nuclear weapons while nowadays there must be about 15 000. And the third problem is related to the changes that disruptive technologies could bring about.

–Talking about reading, you recommend to read about the history rather than the philosophy of science. Why's that?

–I explain it in my lecture 'Advice to a young scientist': "Read, but not too much; publish, but not faster than you can think; and read the history of science". I have nothing against the philosophy of science, on

[117] Alberto Galindo (Zaidin, Huesca, 1934): emeritus professor of physics at the Complutense University of Madrid.

the contrary; but before talking about the philosophy of science, you need to know some science. There were some trends in philosophy, which I know little about, where science was seen as a social construct. According to these trends, theories do not have a real objective value, as they are mere group constructs; and I think that idea has been taken to the extreme. For instance, Hiroshima shows that Einstein's vision was something more than just his vision, as there is a reality, a tragic example, isn't there? That means that behind the theory of relativity and atomic and nuclear physics there is an enormous potential, in this case for destruction. Instead of "philosophy of science", I should have said "some philosophies of science". I also think that, in general, it's not good to ask deep, abstract questions, about things you don't understand, prematurely. It's good to see people trying to understand what there is, cognitively or epistemologically, behind scientific subjects; but, to do so, first you need to understand those scientific subjects. You cannot possibly talk about the philosophy of quantum physics without first knowing about quantum physics. That's why it's better for people to read about the history of science, which is meant to be the history of ideas explained by the people who constructed those ideas, and not by people who got them second-hand.

–For example?

–Read Planck, read Einstein; because that's where you see their hopes and their disappointments, their sentimental side, their irrational aspects…, everything going along with a scientific idea, both as an intellectual adventure and as an evolution of ideas. That's why it is better to approach the history of science first. This is just a practical advice; there will be time, later on, when you know more, to tackle the philosophy of science. One of the important characteristics of science is that it must describe reality. That means that the beauty of an idea is not enough for it to be valid; the idea needs to conform to reality, it must pass the experiment. Empiricism is the main characteristic of science. In fifty years, no one will know who the Queen of England was in 1953: never mind; but everybody will know that in 1953 the DNA double-helix structure was discovered in Cambridge.

The history of science is important; it is the history of the development of humankind.

Why be a scientist? Etxenike answered that question in his article 'In memory of Phil W. Anderson (1923-2020): a polifacetic and exceptional scientist'[118]:

"The reasons why somebody might like to be a scientist are varied and complex. Generally speaking, you need to have intellectual curiosity, the desire to find a truth that we scientists believe to exist. The second factor is professional pride, as in the case of good artisans: an inner will leading you to want to do things well. And, lastly, a number of reasons: wanting power and money, and, very important in my opinion, wanting reputation and prestige".

Throughout the interviews, Etxenike confesses on occasion his tendency to vanity:

–I really like being flattered, but not with easy flattery. I do like being told when I do something well. I've read somewhere that flattery is the oil of human relations.

He has a human touch, which he shows in a completely natural way, wherever he is. He is a scientist who likes to introduce himself, with a wink of the eye, as a smuggler from Izaba:

–People are not one-dimensional: we're all polyhedric, aren't we? I like almost everything: I'm a Gemini, a smuggler. I like all sorts of things, that's why I never get bored!

The child who used to be bad at physical education became a multidisciplinary sportsman.

–When we were kids, we used to ski in the mountains and I used to play *pala*[119]. I have run the Behobia-Donostia race fourteen times,

[118] 'En memoria de Phil W. Anderson (1923-2020): un polifacético y excepcional científico', *Revista Española de Física*, July-September 2020.

[119] *Pala*: Basque word for a bat that is typically used to play with a leather or rubber ball in a *fronton*, a two-walled or single-walled court used as a playing area for *Basque pilota* or *Basque pala*.

and two marathons too, one in San Sebastian and the other one in New York in 2000, the year I turned 50. I still go cycling.

He still rides his bicycle as often as he can. He carries with him the experience of someone who has set gears of all types and calibers in motion.

AFTERWORD

A DREAM FULFILLED

Many times, when entering or leaving San Sebastian, the sight of the nanoGUNE building makes me feel a sense of pride. To me, this emblematic building symbolizes the success of the creation in the city of San Sebastian of a small ecosystem of science and technology, of which nanoGUNE is an essential part. It represents the realization of the dream I expressed when I received the city's gold medal twenty years ago. It is a collective work; but in every collective work, in my experience, there are special people. NanoGUNE will always be associated with Basque institutions, in general, and, in particular, with the Basque government and its successive industry departments. Without forgetting many others, it is fair to mention the original promoters of the center: president Ibarretxe and Joseba Jauregizar. The building, splendidly suited to its mission and endowed with state-of-the-art scientific equipment, required substantial funding. Led by Pedro Azpiazu, the Basque Nationalist group at the Spanish parliament negotiated a non-transferable specific allowance. The main architect of nanoGUNE has been its director-general, Txema Pitarke. Without his generosity, intelligence, tenacity, and professional and human leadership, nanoGUNE would have never become the splendid reality it is today, a reality to which all its researchers and staff have also contributed in a major way. The success of the past justifies the faith and hope I have in nanoGUNE's future. When something is built on solid ground, with solid foundations, both the material and conceptual edifice remain and adaptation to unpredictable future changes is guaranteed.

NanoGUNE is the result of Basque autonomy and self-governance. It is the result of a correct policy carried out by the Basque institutions. There are, at least, two conditions for an appropriate scientific and technological policy: long term, the continuity of policies, and a collaborative relationship with public administration. Policy

discontinuity would make it impossible to attract global talent, which is something that has proven to be key at nanoGUNE. A fluid, dynamic relationship between scientists and public administration is essential in order to prevent abstract and uniformizing bureaucracies from impeding the professional development of our talent. NanoGUNE is part of the Basque ecosystem of science and technology. As in any ecosystem, the health of the whole system depends on the health of its constituent parts and, crucially, on the relationship between the parts. Likewise, the health of each part depends on the health of the whole system. We need a harmonious system that takes care of the university, basic research, applied research, development, technology centers, and industry –the industry of the present–, and, at the same time, lays the foundations for the industry of the future. Above all, our institutions must make high-risk investment to guarantee the industry of the future. We need to take fine-tuned care of centers like nanoGUNE, which, in addition to supporting the industry of the present, act as a bridge between today's cutting-edge international science and the Basque industry of the future.

Chairing nanoGUNE for thirteen years has been a highly gratifying honor for me. NanoGUNE is a collective project led by Txema Pitarke and Andreas Berger, who have been able to demonstrate that with intelligent design, a well-thought personnel selection process, and appropriate institutional and economic support it is possible to achieve a combination of cutting-edge science and technology transfer to the productive system. NanoGUNE has been able to do all this in a relatively short period of time, laying, at the same time, the seed for the still very incipient industry of the future.

The brief history of nanoGUNE as told in this book, intelligently written by Elixabete Garmendia in a lively, pleasant style, should help nanoGUNE's future employees, who, along with the new president, Javier Martinez-Ojinaga, should be able to surpass the successes of the past.

Pedro Miguel Etxenike
nanoGUNE's founding President

CHRONOLOGY

February 21, 2005. In Cambridge, Pedro Etxenike asked Txema Pitarke whether he would be interested in starting a new nanoscience center in San Sebastian.

January 10, 2006. A proposal was submitted to the Consolider Program to build a nanocenter. Pedro Etxenike would be the coordinator, and Txema Pitarke the co-coordinator. That year the project received a €4 500 000 grant.

February 28, 2006. The founders of nanoGUNE –DIPC, IK4, Tecnalia, UPV/EHU– created a non-profit association and made nominations: Txema Pitarke would be the director-general of the center, and Pedro Etxenike its president.

September 1, 2006. The first working day: Txema Pitarke, director, Igor Campillo, scientific secretary, and Vanessa Lasaga, administrative secretary, began to work in an office at the Miramon technology park.

September 20, 2006. Etxenike suggested to the Basque Nationalist congressman Pedro Azpiazu seeking a specific allowance for nanoGUNE in the state-budget negotiations with the Spanish government. For the year 2007, 15 million euros were awarded. Over the following years, a specific allowance was negotiated again; in 2008 and 2011, 10 million euros and 600 000 euros were assigned, respectively.

November 28, 2006. The international advisory committee was launched. The first meeting took place at Imperial College, London.

December 13, 2006. Joseba Jauregizar, director of technology, told Etxenike and Pitarke that the Basque government had decided to locate nanoGUNE at the Ibaeta campus of the University of the Basque Country.

December 20, 2006. Pitarke went to Dublin to visit the building construction of the CRANN nanocenter.

February 5, 2007. Pitarke and Campillo held their first meeting in San Sebastian with Wilson Architects from the US.

February 9, 2007. The University of the Basque Country signed off the allocation of a site at the Ibaeta Campus to nanoGUNE.

February 11, 2007. A call to tender for the building-construction project was announced.

March 1, 2007. Miguel Odriozola, finance director, and Maria Rezola, Pitarke's assistant, replacing Lasaga, joined the team.

March 12, 2007. The contract for the building-construction project was signed with the IDOM-SANJOSE temporary business alliance. They completed the project in July.

April 16-20, 2007. Pitarke and Campillo toured the US, visiting nanotechnology centers.

June 28, 2007. The digging up of the foundations of the building began. The building construction took less than seventeen months.

July 1, 2007. Andreas Berger's first day as research director at the Miramon offices.

November 24, 2008. The team left the Miramon offices and moved to the new building at Ibaeta.

January 30, 2009. Official opening of nanoGUNE at Ibaeta. The center had five research groups and about 25 researchers, who came from various countries such as the US, Germany, France, Italy, and the UK, among others.

September 28, 2009. The *Atom by Atom* conference began at the Kursaal in San Sebastian as an initiative to introduce nanoscience and nanotechnology to society.

April 9, 2010. Graphenea, nanoGUNE's first start-up company, was founded. It was followed by Simune (January 2014), Ctech-nano (July 2014), Evolgene (September 2014), and Prospero (October 2015). The sixth company, BioTech Foods, was set up in 2017.

January 30, 2019. Tenth-anniversary celebration. NanoGUNE had ten research groups and about 100 researchers from twenty five countries.

INDEX OF NAMES

Arnes, Sonia. Spanish foundation for science and technology.

Arregi, Jesus Maria. Mathematics lecturer at the University of the Basque Country. Pioneer in lecturing mathematics in Basque.

Arregi, Mikel. Philosophy professor and poet.

Arregui, Gorka. NanoGUNE's facilities manager.

Arriola, Marisa. Managing director of BIC Gipuzkoa.

Artacho, Emilio. NanoGUNE Ikerbasque research professor.

Artze, Joxean. (Usurbil, 1939-2018). Writer, poet, and *txalaparta*[120] player. Member of the *Ez dok Amairu* Basque avantgarde cultural group.

Asua, Jose Maria "Txema". Professor of chemistry at the University of the Basque Country. Director of the Basque Excellence Research Center (BERC) Polymat.

Asuncion, Miryam. NanoGUNE's TechTransfer manager (2008-2018).

Azpiazu, Pedro. Elected member of the Spanish parliament for the Basque Nationalist Party (2000-2016). Minister of economy and finance of the Basque government since 2016.

Barreda, Leopoldo. Elected member of the Basque and Spanish parliaments for the conservative party *Partido Popular* (2011-2016).

Baztarrika, Patxi. Chief of Staff of the president of the regional government of Gipuzkoa under Roman Sudupe (1999-2003). Vice-minister of language policy of the Basque government (2012-2016).

Binnig, Gerd. Physics Nobel Laureate (1986). He shared the Physics Nobel prize with Heinrich Rohrer for the scanning tunneling microscope.

Bittner, Alexander. NanoGUNE Ikerbasque research professor.

Blake, William. (London, 1757–1827). Romantic poet and artist.

[120] *Txalaparta*: Basque music instrument made of wood or stone.

Blanco, Javier. Director of the *Euskadiko Kutxa* bank in Areeta (Bizkaia) in 2006.

Bohr, Niels. (Copenhagen, 1885-1962). Physics Nobel Laureate (1922). He made pioneering foundational contributions to the development of quantum theory.

Buggenhout, Jean-François. Head of the 'Flagships' unit at the European Commission.

Campos, Jose Antonio "Tontxu". Member of the Basque political party *Eusko Alkartasuna*. Minister of education, universities, and research of the Basque government (2005-2009).

Carrera, Miguel Angel. General manager of *AVS* (Elgoibar, Gipuzkoa).

Casanova, Felix. NanoGUNE Ikerbasque research professor.

Castelruiz, Yurdana. NanoGUNE's projects manager.

Chuvilin, Andrey. NanoGUNE Ikerbasque research professor.

Colmenero, Juan. Professor of physics at the University of the Basque Country. Director of the DIPC and the Materials Physics Center in 2006.

Corchete, Gorka. IDOM engineer. Project manager of nanoGUNE's building construction.

Cuerda, Carlos. Founder of Naider consulting.

De la Fuente, Jesus. General manager of *Graphenea*.

De Oliveira, Thales. Partner and researcher of *Prospero Biosciences* (2015-2017); he did his PhD at nanoGUNE.

Dell, Anne. Professor of biochemistry at Imperial College, London, UK. Member of nanoGUNE's international advisory committee.

Diez-Muiño, Ricardo. Scientific researcher at the Spanish Research Council. Director of the DIPC since 2013.

Dogterom, Marileen. Professor of bionanoscience at Delft University of Technology. Member of nanoGUNE's international advisory committee.

Dorronsoro, Guillermo. Director of IK4 Research Alliance (2004-2007).

Echaniz, Esther. Manager of the area of cooperation and business services at the Gipuzkoa Science and Technology Park.

Egaña, Alfonso. BioGUNE's finance director.

Egaña, Andoni. *Bertsolari* (verse improviser) and writer.

Elorza, Odon. Basque Socialist Party. Mayor of San Sebastian (1991-2011). Promoter of the Talent House initiative.

Estornes Lasa, Bernardo. (Izaba, 1907-1992). Writer and founder, along with his brother Mariano, of Auñamendi publishers.

Etxebarria, Jose Ramon. Physics lecturer at the University of the Basque Country. Pioneer in lecturing on science and technology in Basque.

Gabilondo, Iñaki. Reporter, radio broadcaster, and television presenter on various Spanish media outlets.

Galindo, Alberto. Emeritus professor of physics at the Complutense University of Madrid. A pioneer in Spanish theoretical physics.

Garaikoetxea, Carlos. Basque Nationalist Party and Basque political party *Eusko Alkartasuna*. President of the first two Basque governments after Franco's dictatorship (1980-1985).

Garcia Egocheaga, Javier. (San Sebastian, 1940-2002). Minister of industry of the Basque government (1980-1983).

Garmendia, Francisco "Pako". (Azpeitia, 1946-2015). Professor of sociology at the University of Deusto. Secretary of language policy of the Basque government (1980-1984).

Geim, Andre. Physics Nobel Laureate (2010). He shared the Physics Nobel prize with Konstantin Novoselov for their groundbreaking experiments on graphene.

Guerra, Mikel. Director of IDOM's office in San Sebastian.

Guridi, Jose Ramon. Deputy of innovation and knowledge society of the regional government of Gipuzkoa in 2010.

Heine, Volker. Professor of physics at the University of Cambridge.

Hernaez, Estibaliz. Vice-minister of technology, innovation, and competitiveness of the Basque government.

Hewish, Anthony. Physics Nobel Laureate (1974).

Hillenbrand, Rainer. NanoGUNE Ikerbasque research professor.

Howie, Archie. Professor of physics at the University of Cambridge. Director of the Cavendish Laboratory (1989-1997).

Hueso, Luis. NanoGUNE Ikerbasque research professor.

Isasti, Andoni. General manager of *Cadinox* (Belauntza, Gipuzkoa).

Iturbe, Jazinto. Chemistry lecturer at the University of the Basque Country. Pioneer in lecturing on chemistry in Basque.

Kaltzada, Pilar. Journalist and writer, communication expert.

Kinaret, Jari. Director of the *Graphene Flagship* initiative.

Knez, Mato. NanoGUNE Ikerbasque research professor.

Lasaga, Vanessa. NanoGUNE's director's first assistant in 2006.

Lehn, Jean-Marie. Chemistry Nobel Laureate (1987). Member of nanoGUNE's international advisory committee.

Lete, Xabier. (Oiartzun, 1944-2010). Writer, poet, and singer. Member of the *Ez Dok Amairu* Basque avantgarde cultural group.

Lopez, Francisco "Patxi". Basque Socialist Party. President of the Basque government (2009-2012).

Lopez-Basaguren, Alberto. Professor of constitutional law at the University of the Basque Country.

Lozano, Javier. Consultant at Socintec consulting in 2006.

Lujanbio, Maialen. *Bertsolari* (verse improviser) and writer.

Madrazo, Javier. General coordinator of the Basque United Left-Greens party (1995-2009). Minister of housing and social affairs of the Basque government (2001-2009).

Maiz, Jose Antonio. Intel engineer. He was appointed *Intel Fellow* in 2002, for his outstanding technical contribution to the company. Member of nanoGUNE's international advisory committee.

Maragall, Pasqual. Catalan Socialist Party. President of the Catalan Government (2003-2006).

Martin-Lomas, Manuel. Scientific director of biomaGUNE (2006-2012).

Martinez, Carlos. Secretary of state of research of the Spanish government (2008-2009).

Martinez-Ojinaga, Javier. CAF counselor. President of nanoGUNE since 2019.

Mato, Jose Maria. Director of bioGUNE.

Maxwell, James Clerk. (Edinburgh, 1831-1879). Scottish scientist. Father of electromagnetism.

Mecerreyes, David. Ikerbasque research professor at the University of the Basque Country. Head, in 2006, of the nananotechnology unit at Cidetek-IK4.

Mendez, Emilio. Director of the Center for Functional Nanomaterials (CFN) at Brookhaven National Laboratory in the US (2006-2016). Member of nanoGUNE's international advisory committee.

Mitxelena, Koldo. (Errenteria, 1915-1987). Linguist and writer. Architect and promoter of the unification of the Basque language.

Montejo, Lorena. In charge of *The Lighthouse of Voices* in the framework of *Donostia European Capital of Culture 2016*.

Monzon, Telesforo (Bergara, 1904-1981). Basque Nationalist Party and Basque political party *Herri Batasuna*. Politician and writer.

Morras, Esteban. Founder of *Das-Nano*.

Muguruza, Josu. (Bilbao, 1958-1989). Elected member of the Spanish parliament for the Basque political party *Herri Batasuna*. He was assassinated at Alcala Hotel in Madrid in an attack claimed by the GAL paramilitary group.

Nixon, Richard. President of the United States (1969-1974).

Novoselov, Konstantin. Physics Nobel Laureate (2010). He shared the Physics Nobel prize with Andre Geim for their groundbreaking experiments on graphene.

Obieta, Isabel. In charge, in 2006, of the nanotechnology unit at Inasmet-Tecnalia.

Olano, Markel. Basque Nationalist Party. President of the regional government of Gipuzkoa.

Oliveri, Iñaxio. Basque Nationalist Party and Basque political party *Eusko Alkartasuna.* Minister of education, universities, and research of the Basque government (1995-2001). President of Mondragon University (2002-2006).

Ordejon, Pablo. Professor of physics at the Spanish Research Council. Director of the Catalan Institute of Nanoscience and Nanotechnology ICN2. Co-founder of *Simune* (2014).

Ormazabal, Patxi. Basque Nationalist Party and Basque political party *Eusko Alkartasuna*. Minister of territorial planning, housing, and the environment of the Basque government (1995-2001).

Ortega, Enrique. Professor of physics at the University of the Basque Country. Researcher at the DIPC and the Materials Physics Center.

Osa, Eusebio "Sakone". (Bergara, 1936-1993). Writer and head of the Basque-language office at the University of the Basque Country.

Palacios, Juanjo. Professor of physics at the Autonomous University of Madrid. Co-founder of *Simune* (2014).

Pascual, Jose Ignacio "Nacho". NanoGUNE Ikerbasque research professor.

Pascual, Pedro. (Seville, 1934-2006) Professor of physics at the University of Barcelona, the Complutense University of Madrid, and the University of Valencia.

Pazos, Gorka. NanoGUNE's external-services manager.

Pendry, Sir John. Professor of physics at Imperial College, London, UK. Chair of NanoGUNE's international advisory committee.

Perdew, John. Professor of physics at Temple University, Philadelphia, USA.

Perez-Iglesias, Juan Ignacio "Iñako". Professor of biology at the University of the Basque Country. Rector of the University of the Basque Country (2004-2008). President of *Jakiunde* since 2020.

Perez-Jimenez, Raul. NanoGUNE Ikerbasque research professor.

Pethica, Sir John. Professor of physics at the University of Oxford. Founding director of CRANN (Center for Research on Adaptive Nanostructures and Nanodevices) in Dublin. Member of nanoGUNE's international advisory committee.

Pippard, Brian. (London, 1920-2008). Cavendish professor (1971-1982).

Plazaola, Fernando. Vice-rector of research of the University of the Basque Country (2009-2016). Dean of the faculty of science and technology at the University of the Basque Country.

Pozo, Rogelio. Director of Azti.

Prieto, Mikel. Projects director of *Sener* engineering.

Rees, Martin. Professor of cosmology and astrophysics at the University of Cambridge.

Ritchie, Rufus. (Blue Diamond, 1924-2017). Professor of physics at the University of Tennessee. Doctor *Honoris Causa* (1992) at the University of the Basque Country.

Rodriguez-Zapatero, Jose Luis. Spanish Socialist Party. President of the Spanish government (2004-2011).

Rohrer, Heinrich. (Buchs, 1933-2013). Physics Nobel Laureate (1986). He shared the Physics Nobel prize with Gerd Binnig for the scanning tunneling microscope. Member of nanoGUNE's international advisory committee (2007-2013).

Romero, Rafaela. Basque Socialist Party. President of the General Assembly of Gipuzkoa (2007-2011).

Rudolf, Petra. President of the European Physical Society. Professor of physics at the University of Groningen.

Ruiz, Javier. Consultant at Socintec consulting in 2006.

San Jose, Javier. The architect who designed nanoGUNE's site building.

San Martin, Juan. (Eibar, 1922-2005). Promoter of Basque culture, writer, and member of the Academy of the Basque Language. Ombudsman of the Basque Country (1989).

Sanchez-Portal, Daniel. Professor of physics at the Spanish Research Council. Director of the Materials Physics Center.

Santamaria, Antxon. Emeritus professor of chemistry at the University of the Basque Country.

Santamaria, Carlos. (San Sebastian, 1909-1997). Mathematician, writer, and promoter of a Basque university.

Seifert, Andreas. NanoGUNE Ikerbasque research professor.

Setien, Jose Maria. (Hernani, 1928-2018). Bishop of the diocese of San Sebastian (1979-2000).

Simo, Daniel. General manager of *Simune*.

Soler, Jose. Professor of physics at the Autonomous University of Madrid. Co-founder of *Simune* (2014).

Sudupe, Roman. Basque Nationalist Party. President of the regional government of Gipuzkoa (1995-2003). Promoter of the *Fellows Gipuzkoa* program.

Tapia, Arantxa. Minister of economic development, sustainability, and the environment of the Basque government.

Telleria, Joakin. Director, in 2006, of the Gipuzkoa Science and Technology Park.

Telletxea, Iñaki. Vice-minister, in 2006, of technology and industrial development of the Basque government.

Txurruka, Jesus Maria. Biology lecturer at the University of the Basque Country. Pioneer in lecturing on biology in Basque.

Ugalde, Jesus Maria. Professor of chemistry at the University of the Basque Country. President of *Jakiunde* (2012-2020).

Uriarte, Cristina. Minister of education, language policy, and culture (2012-2016) and minister of education (2016-2020) of the Basque government. Commissioner of science, technology, and innovation of the Basque government.

Urkullu, Iñigo. Basque Nationalist Party. President of the Basque government.

Vavassori, Paolo. NanoGUNE Ikerbasque research professor.

Vila, Mercedes. Scientific director of *Ctech-nano* (2015-2019) and scientific director of *BioTech Foods* since 2019.

Villate, Jose Maria. Director of marketing and technology of Tecnalia (2002-2007). Director of Innobasque (2007-2017).

Winter, Hans-Peter. (1941-2006). Austrian physicist.

Zarate, Enrique. NanoGUNE's outreach manager (2009-2012). Professor of physics at Mondragon University.

Romero, Agirre, Martinez, Etxenike, Ibarretxe, Pitarke, Olano, and Campos, at nanoGUNE's opening event (30-01-2009).

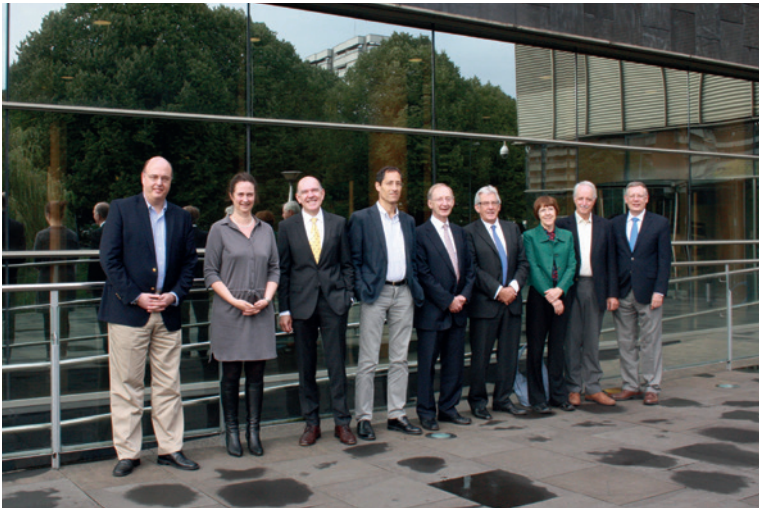
NanoGUNE's 5th anniversary celebration (30-01-2014).

NanoGUNE's 10th anniversary event (30-01-2019).

Pitarke, Etxenike, and president Urkullu (30-01-2019).

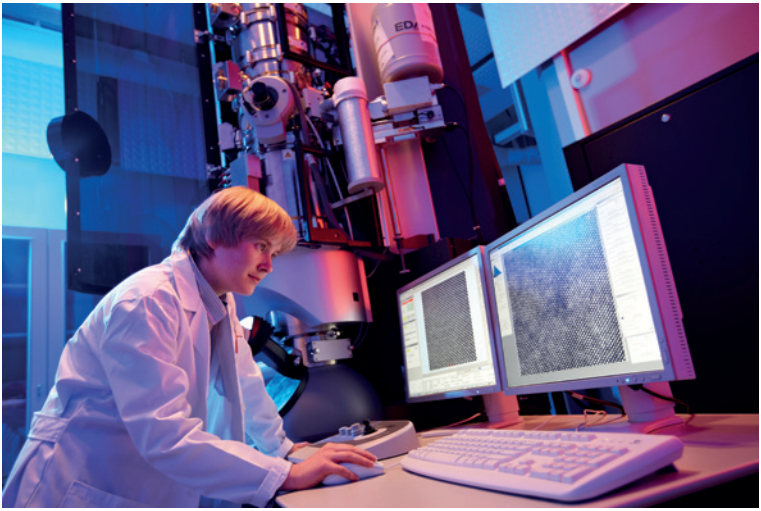
Ibarretxe and Pitarke, Urkullu at the back (30-01-2019).

NanoGUNE's 10th anniversary celebration (30-01-2019).



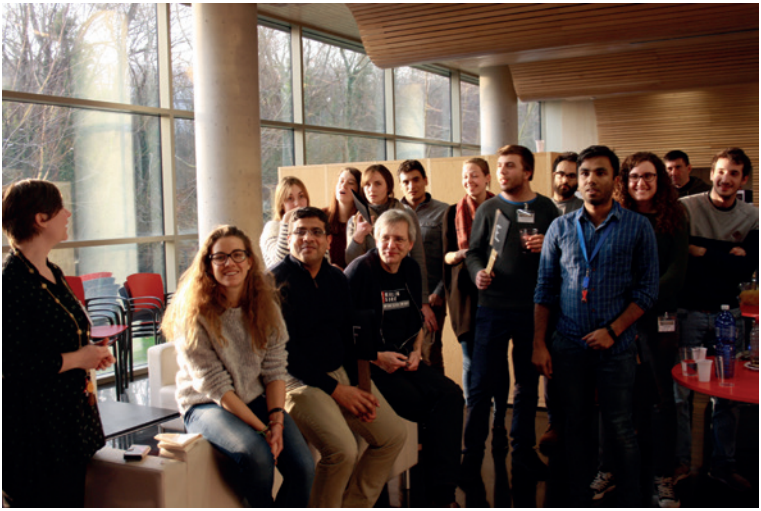
NanoGUNE's international advisory committee: Berger, Dogterom, Maiz, Pitarke, Pendry, Etxenike, Dell, Pethica, and Mendez (2017).

Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN) in Dublin: Bill Wilson, IDOM engineers, and Pitarke (April 2007).



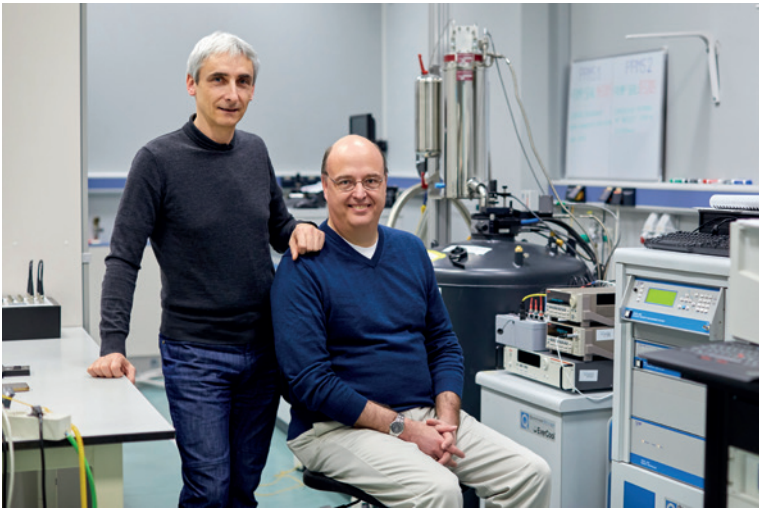
Electron-Microscopy Laboratory.

Opening of nanoGUNE's incubator *nanoHabia:* Pitarke, Etxenike, Jose Ramon Guridi, and Marisa Arriola (2010).



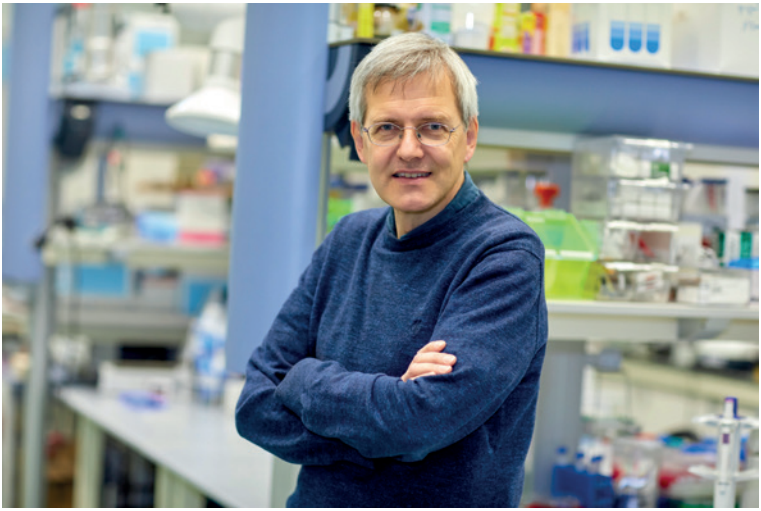
Researchers from ten countries: Italy, Slovenia, Pakistan, Germany, France, India, Spain, USA, Netherlands, and Croatia, in addition to local Basque researchers.

Playnano (22-11-2012).



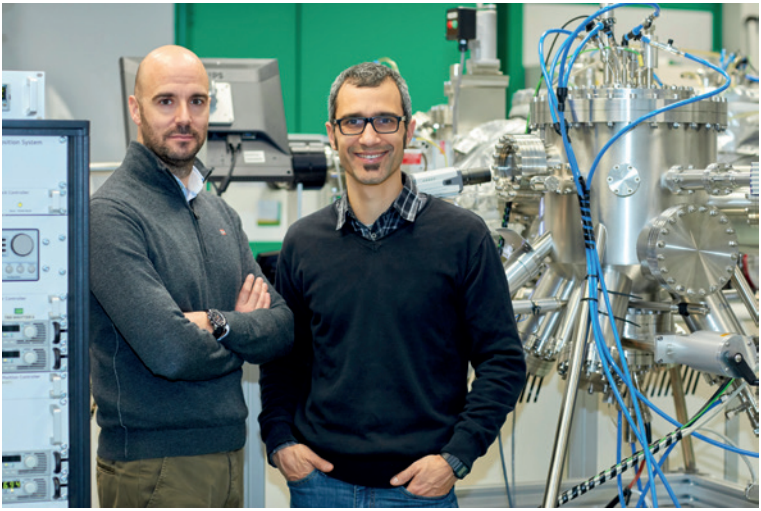
Paolo Vavassori and Andreas Berger, nanomagnetism group leaders.

Rainer Hillenbrand, nanooptics group leader.

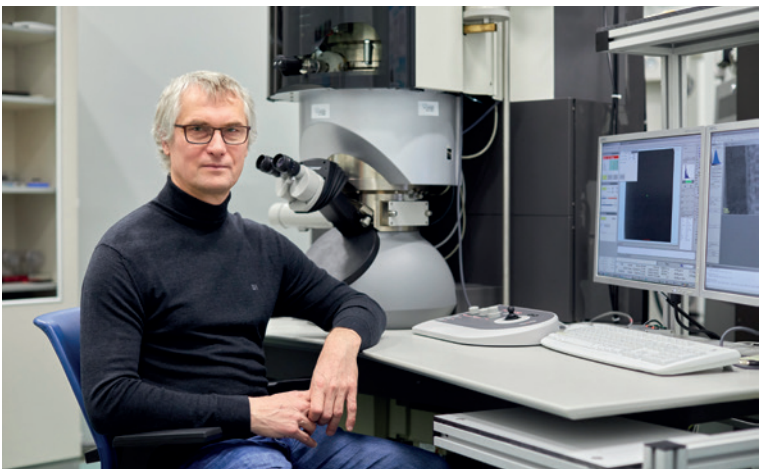


Alexander Bittner, self-assembly group leader.

Raul Perez-Jimenez, nanobiotechnology group leader.

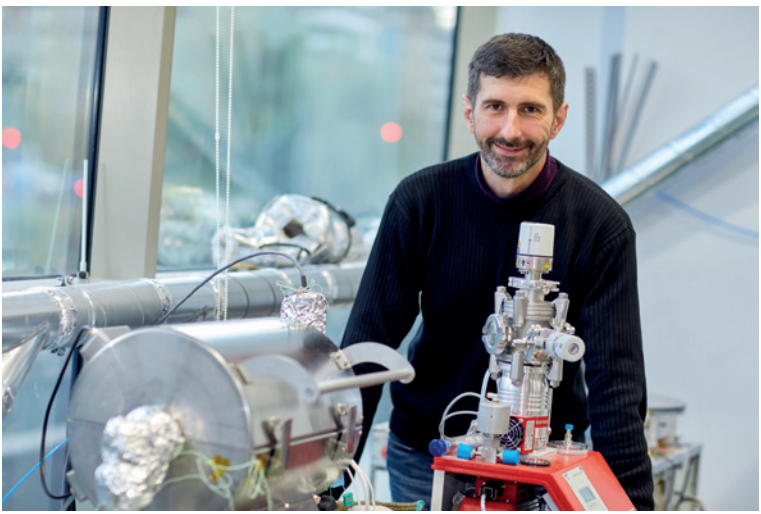


Luis Hueso and Felix Casanova, nanodevices group leaders.

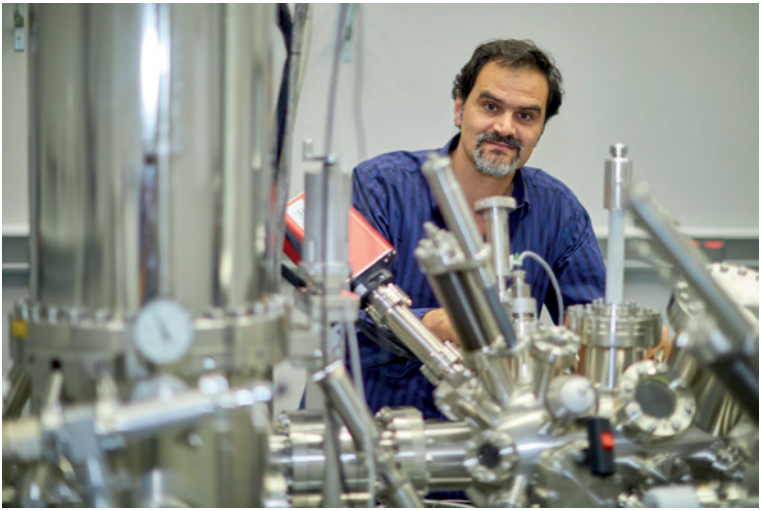


Andrey Chuvilin, electron-microscopy group leader.

Emilio Artacho, theory group leader.



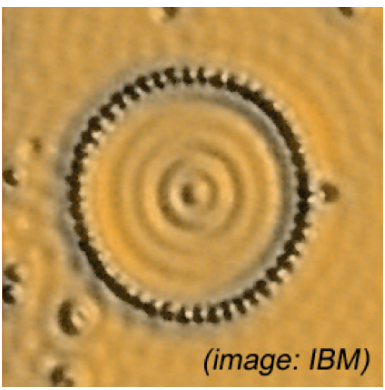
Mato Knez, nanomaterials group leader.



Jose Ignacio "Nacho" Pascual, nanoimaging group leader.

Andreas Seifert, nanoengineering group leader.

Photolithography bay of the cleanroom.



Quantum corral.

Opening of the *Atom by Atom* event: Etxenike, president Lopez, and Pitarke (2009).

Rohrer and Etxenike, at the *Atom by Atom* event (2009).

Andre Geim giving a lecture at the Graphene Week in San Sebastian (2018).

Graphene Week in San Sebastian (2018): Aizpuru, Tapia, Pitarke, Urkullu, Kinaret, Buggenhout, and Uriarte.

NanoGUNE stand at the Science Week organized by the University of the Basque Country.

Pitarke at nanoGUNE addressing a group of visitors (2019).

Nanopeople (2020).

A team of people from twenty-six countries (2020).