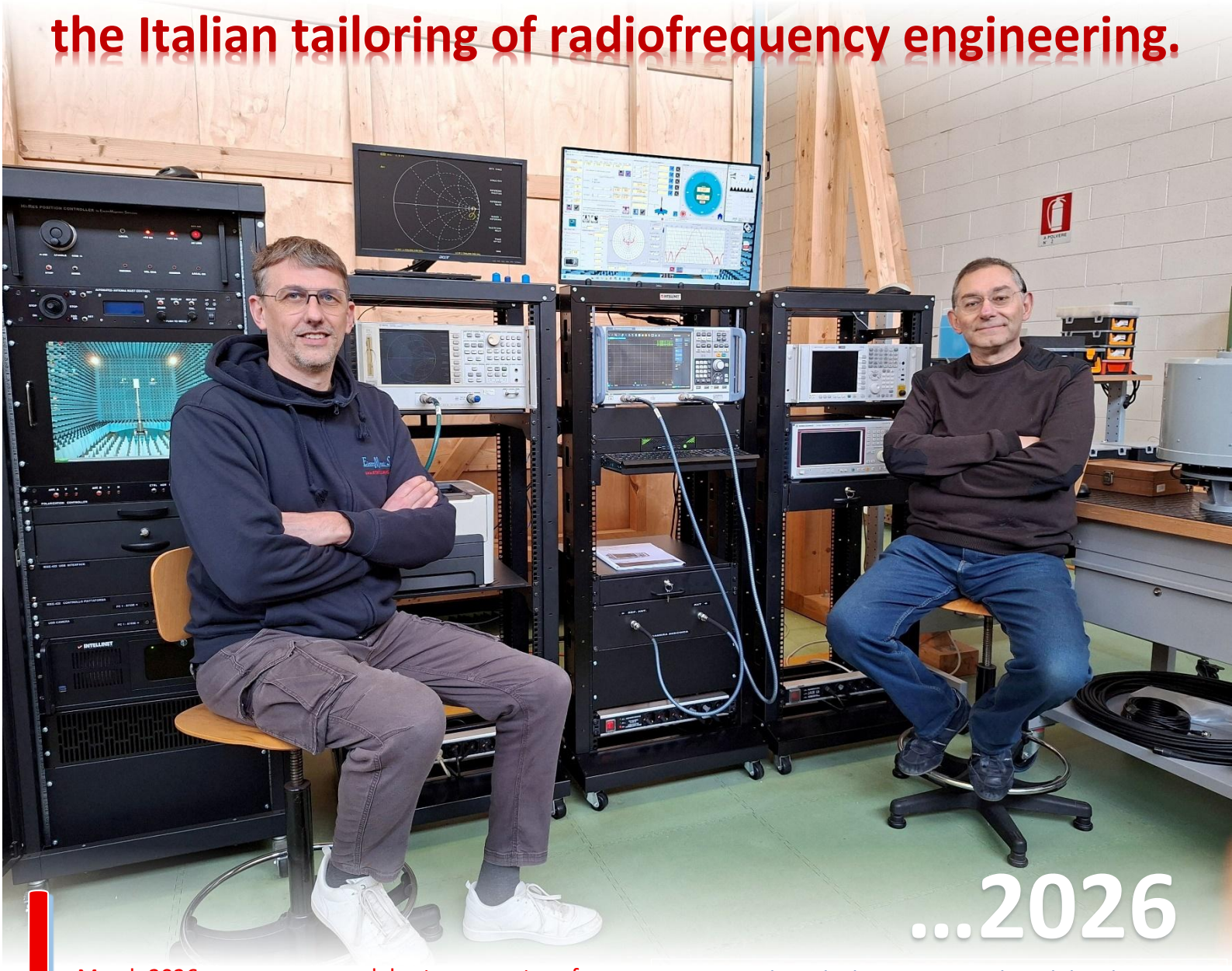
Technical E-Paper

25 years of *ElettroMagnetic Services*:

the Italian tailoring of radiofrequency engineering.



In March 2026, our company celebrates a quarter of a century of activity.

Time has passed quickly, probably because we have never been bored, and even today, more than ever, we remain passionate about our work.

Over the course of these twenty-five years, we have witnessed many changes in the field of radiocommunications, and through our projects we have supported numerous technological sectors, always remaining, by deliberate choice, faithful to a vision of a company in which every decision and strategy is driven exclusively by technical considerations, rather than by commercial or speculative motives or, even worse, by the consequences of poor internal organization.

In a period in which even research and development is increasingly structured through production silos, we take pride in having maintained an atelier mindset: that of a technological craft workshop that allows us to create custom antennas as if they were tailored garments.

On this occasion, we will not focus only about antennas, but rather explain our company philosophy, which over the years has led us to address increasingly complex projects, while at the same time allowing us to collaborate with companies, universities and research institutes, carrying out projects with increasingly advanced approaches and on ever more sophisticated topics.

1. The scenarios and environments we come from.

More than 30 years after graduating in Electronic Engineering and completing a subsequent PhD in the field of space telecommunications, when looking back at the first half of the 1990s I cannot help but observe how many sectors in which we now work on a daily basis were, at that time, unknown or even almost disregarded.

In that period, within the academic environment I attended, there was still no awareness of all those innovations that would later become widely known with the beginning of the new millennium. Interest in wireless technologies seemed largely confined to satellite communications at millimetre-wave frequencies, where there was a significant intellectual investment in what, as an engineer, I would define as a fundamental discipline: the propagation of microwaves to and from the satellite. This was, in itself, a highly advanced field of expertise but, from my perspective, it was significantly lacking in the "hardware" side of research.

Studies and projects on antennas, even those operating at lower frequency bands, were not only outside the main academic focus but were also regarded, from a career perspective, as something unproductive and of little relevance for the future. In reality, this view was not entirely unreasonable, since, for example, the IEEE 802.11 protocol would only appear towards the end of the millennium, and at that time optical fiber seemed to be the *deus ex machina* for all connectivity challenges on Earth.

With the passage of time, and fortunately for me, three sectors that are fundamental to our company quickly became highly relevant starting in the early 2000s, disproving the myth that the state of the art belonged exclusively to space telecommunications:

1. Wi-Fi and IoT, particularly the latter for the development of integrated antennas;
2. Mobile radio, from the 900/1800 MHz bands of the mid-1990s to the new higher frequency bands introduced with 4G and 5G;
3. Antennas in the HF/VHF/UHF bands, both for military applications and for scientific research, particularly with reference to the revival of shortwave as a strategic resource thanks to new, robust digital communication protocols and ALE (Automatic Link Establishment) techniques.

The offshore internships I had the opportunity to undertake as a student, both with *Radio Vaticana* and with the then *CSELT* in Turin (thanks to the remarkable openness of my tutor at the time), proved extremely valuable when I entered the professional world, leading to an immediate full-time position in the R&D department—then known simply as "the laboratory"—of a major company that, needless to say, specialized in antennas.

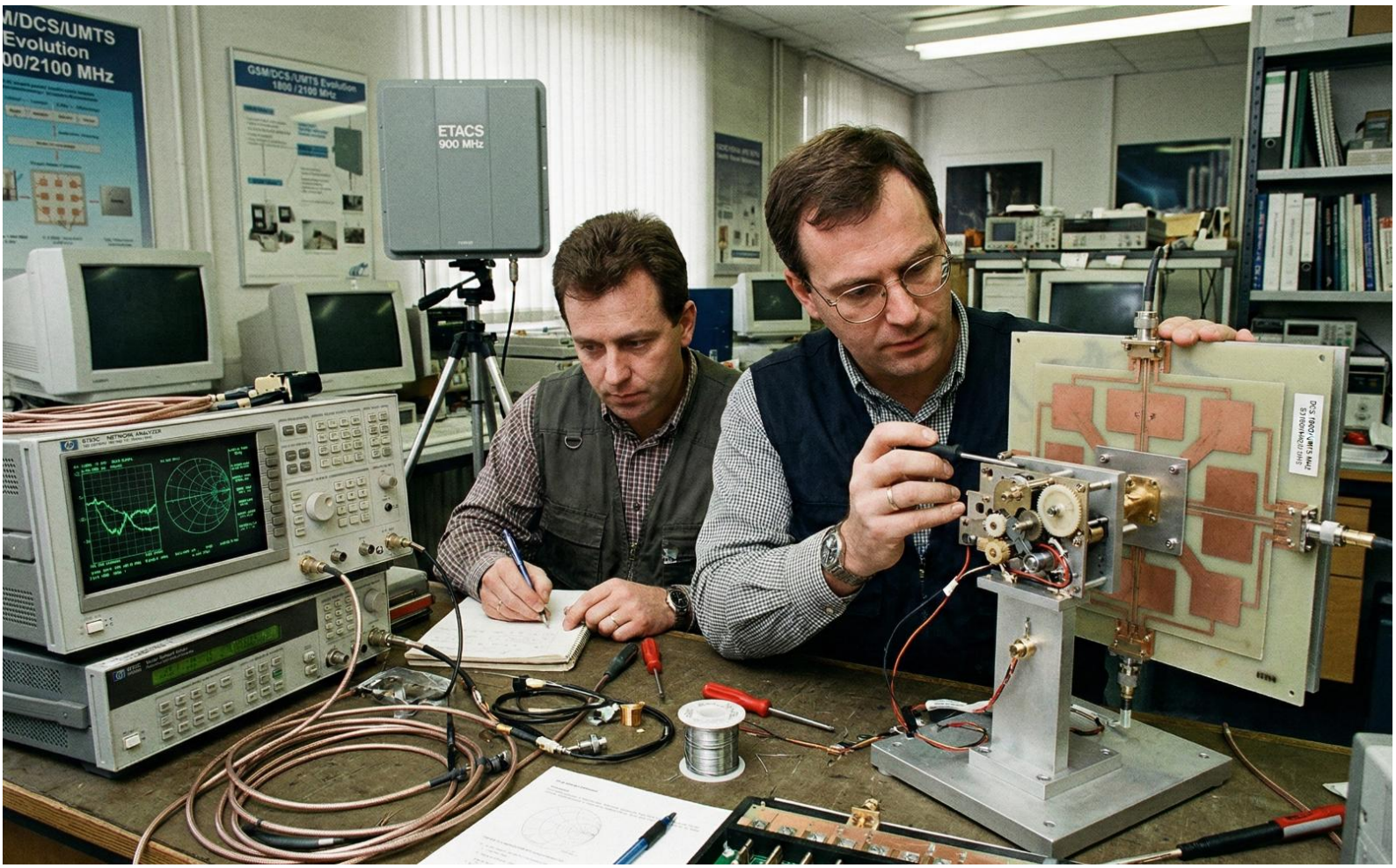
In this new world I had entered, during the second half of the 1990s work was carried out intensively on GSM antennas for the DECT, DCS and UMTS bands, as the 1800 MHz and 2100 MHz bands were still relatively new compared with the large 900 MHz panels used for the ETACS network. This was the period of planar arrays, dual-polarization panels, and sophisticated electromechanical devices designed to implement variable beam down-tilt.

As modern electromagnetic modelling software was not yet widely available, the development of an antenna or a radiofrequency component required an extensive phase of practical experimentation and manual optimization, carried out by skilled technicians with refined craftsmanship, supported by repeated laboratory measurements.

The next professional opportunity that arose, and which I promptly decided to seize, involved a much smaller company where, despite the inevitable involvement of management, it was possible to oversee the entire organization of the project and the production process—an aspect that proved extremely valuable for gaining knowledge of the materials, manufacturing processes, and technologies used by suppliers.

On that occasion I met my current business partner, Flaminio, also a skilled technician, and together we later developed the idea of founding our own company, based on the principle of providing high-level expertise that would be, above all, technically independent.

Where did this idea come from, and what inspired it? We will return to this point shortly.



…" As modern electromagnetic modelling software was not yet widely available, the development of an antenna or a radiofrequency component required an extensive phase of practical experimentation and manual optimization, carried out by skilled technicians with refined craftsmanship, supported by repeated laboratory measurements."...

2. Old and new corporate structures.

The idea of writing an article different from the usual ones, in which we do not speak only about antennas, arose from a topic that has recently attracted my attention: the crisis of the automotive industry, especially in Italy and in Europe. In this field, which is completely different from wireless, there are in fact many similarities in terms of philosophies, organizational models and attitudes that I have already observed during my professional career in telecommunications. Both of these sectors could indeed be described as technological, complex and multidisciplinary.

In the 1950s and 1960s, the golden age of economic growth and of the automobile, the organization of a project placed the "experimental department" (today called R&D) at the top of the corporate hierarchy. At its head was a director—an engineer with a technical background—who stood at the top of an almost military-style hierarchical structure, in the sense that every decision ultimately referred to this figure, who was obviously capable of managing it and deciding autonomously.

We are in the era of the "Great Old Men" or designer-autocrats, when corporate structures were pyramidal and strongly centered on a single technical vision. Examples of this approach include engineers Alec Issigonis, inventor of the Mini (1959), and Dante Giacosa (shown in the background), the father of many FIAT projects, including the Nuova 500 (1957).

Below them there were no autonomous departments, but rather "high-level implementers". Technical draftsmen received hand-drawn sketches (Issigonis' drawings on napkins or cigarette packs are well known) and had the task of translating them into technical drawings, models and prototypes, whose supervision and approval always remained the exclusive responsibility of the "Great Old Man" (... the era of Bocconi-style management had not yet begun).

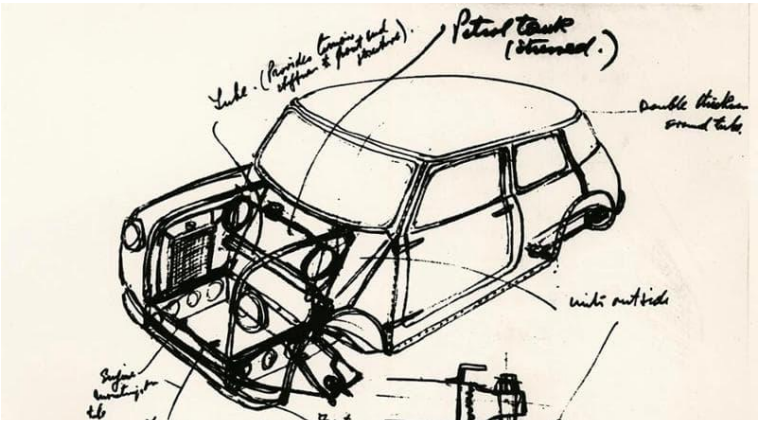
The overall vision of the project held by a single person of high technical competence—capable of anticipating or managing inconsistencies, errors or changes during the course of development, and acting as an authoritative arbiter among the various departments responsible for the different subassemblies of the vehicle—led to the definition of a highly optimized and reliable product, because it was built with parts and components designed specifically for that particular purpose.

Over the years, the organization of research and development within companies has undergone a radical transformation. This new approach is based on the underlying idea that the management of any complex technological project can be effectively carried out by applying purely financial and managerial methodologies, without requiring the manager—the figure that replaces the holistic vision of the former chief engineer—to necessarily have a technical background or a deep knowledge of the technologies and industrial history of the company.

This transformation has led to two structural phenomena: the fragmentation of departments and black-box design.

Fragmentation occurs when the development of a complex technological product, such as an automobile, is divided among dozens of closed departments (the "silos") that communicate with each other horizontally through rigid protocols and software interfaces.

The product is thus divided into numerous subassemblies, often employing different and proprietary technologies—the so-called black-boxes—which communicate



The first, almost Leonardo-like, sketch of the Mini, created by Alec Issigonis.

with one another exclusively through high-level requirements, that is, “external” specifications that do not in any way imply knowledge or know-how of the subassemblies used.

Although this organizational structure is partly justified by technological progress, which has led to a significant increase in product complexity, it is precisely this complexity that raises doubts about how cause-and-effect relationships between the different black boxes are managed, namely:

- are high-level specifications always sufficient to guarantee the correct and/or reliable operation of two or more subassemblies under real operating conditions, that is, when they are integrated into the vehicle?
- how is the debugging of a problem managed when it may potentially involve more than one black-box?
- are error correction, modifications and improvements involving multiple production silos or black-boxes easy to implement?
- how is any correction that requires temporarily reversing the workflow across multiple departments actually managed?

These brief concepts drawn from the automotive world obviously do not claim to be exhaustive, nor to represent the sole cause of the deep difficulties affecting this entire sector, but they provide a starting point from which to explain how, over the years, we have chosen to organize our company.

3. Growth, investments and management of custom projects.

The idea of founding an *intellectually independent* company arose from certain differences in perspective that both my partner and I gradually came to develop during our previous educational and professional experiences. These differences in perspective did not, of course, emerge immediately, but slowly became apparent as our professional experience progressed.

Without going into detail (the intention here is not to criticize the business choices of others, but simply to explain how we made our own), it was, for example, clear how difficult it was to establish contact with other departments—from the workshop to production—as well as with suppliers and customers, in order to follow the history of a project through the subsequent phases of engineering, assembly and testing. In the case of suppliers, the “laboratory” (that is, research and development) found it impossible to gain insight into the technologies and costs of the parts required for a given project, while, with regard to customers or contracting parties, any contact—obviously aimed solely at understanding and satisfying technical requirements—was entirely managed by a salesperson with only limited knowledge of the product.

Instead of being perceived as causes of inefficiency, the compartmentalization of departments and the antagonism among individuals was promoted as drivers of productivity, within a climate of general mistrust. This approach, combined with short-sighted commercial strategies lacking a global vision of the product, often led to projects being weighed down by unnecessary constraints, laying the groundwork for frequent post-sales issues.

This led us, in 2001, to establish *ElettroMagnetic Services*, a company specialized in the design and development of custom antennas, entirely our own and based on three fundamental principles: *technical and intellectual independence; absolute transparency and sincerity in our relationships with customers; the application of a technocratic approach to project management.*

3.1. Technical and intellectual independence.

We believe that independence and autonomy, both from a technical and intellectual standpoint, form the foundation of any creative process of value and high innovative content, whether artistic or technical-scientific, as in our case.

While operating with modern technologies and instrumentation, we still draw inspiration from the great engineers of the past, who were capable of developing a product starting from a blank sheet, optimizing all

phases and components of the project down to the lowest-level specifications. This obviously requires interdisciplinary knowledge of different technologies, materials and suppliers, which we consider a fundamental competence in our field and, of course, something we always regard as an “ongoing process”, that is, in continuous evolution.

Errors, corrections and improvements can thus be managed in any part or phase of the project without losing sight of the overall vision of the final result, especially when a product optimized for specific applications is required. If an error emerges during testing, those who possess intellectual independence do not need to convene a committee of rival departments to address the problem: we believe, in fact, that the effective management of a complex project cannot be managed effectively through a democratic process.

Over the years, following this approach has led us, by choice, not to expand the company by shaping it into a large-scale production department. On the contrary, we are organized as an atelier, in which the two partners maintain direct and complete control over every phase of development and production, and personally manage every communication—direct and transparent—with the customer.

3.2. Sincerity and transparency in relationships with customers.

The first principle would remain incomplete without a relationship of transparency, sincerity and loyalty towards our customers. The development of custom projects, based on electrical, mechanical or environmental requirements defined by the customer or by the specific application, involves the evaluation of specifications whose feasibility must be determined and clearly stated already at the preliminary stage. Direct control over every phase of a project allows us to build a close relationship with the customer, without the filters of commercial departments that, in order to sell, promise specifications that are in fact unattainable.

Antennas, as transducers that convert electrical current (RF) into intangible electromagnetic waves, have always been difficult to measure objectively for those who do not possess adequate expertise and instrumentation. In certain sectors of wireless technology, the commercial practice of “improving” antenna specifications beyond the physical limits imposed by the laws of electromagnetism has, over time, become quite common—so widespread that datasheets do not reflect the antenna’s actual performance are sometimes used as reference standards in tenders or procurement processes. To be clear, there have been occasions when we have renounced projects simply for telling the truth: if the initial specifications are physically inconsistent, we prefer to point this out to the customer immediately rather than be unable to guarantee the final result later on.

3.3. Technocracy in the management and execution of a project.

At ElettroMagnetic Services, the management of every project follows a technocratic vision rooted in the rigorous rationality of figures such as Alec Issigonis and Dante Giacosa.

From the very early stages of defining the specifications of a custom antenna, the company philosophy requires that engineering excellence—rather than mere commercial compromise—dictate the evolutionary direction of the product. As in the functional design of the great masters of industry, where every detail was justified by a mechanical and performance-related necessity, at ElettroMagnetic Services every design choice responds exclusively to the pursuit of the best possible technical solution. Our objective is not only to deliver an antenna that meets the design parameters, but to provide a product that is not a “black box” for the customer.

It is essential that anyone who commissions a project—whether supplied on a turnkey basis or including subsequent production—understands the operating principles and the technical choices underlying its development. The customer has the right to receive an exclusive product and to manage it in full autonomy, without secrets, hidden costs, or technical dependencies on the supplier.

4. Custom antennas in strategic sectors.

In this scenario, updated to 2026, we would like to share our vision regarding the use of custom antennas with advanced technical requirements in some of the main sectors in which we operate.

4.1. The Wi-Fi sector.

Since the beginning of the new millennium, the Wi-Fi sector has undergone an unprecedented evolution, leading to the standardization of models and antennas for the **2.4 GHz, 5 GHz and WiMAX bands**. Initially, innovation involved traditional radiating systems, such as directional panels and sector antennas; however, the subsequent competitive pressure from Asian markets flooded the market with low-cost, large-scale solutions.

In this context, special applications often remain underserved: today more than ever, these niches require products developed specifically for the application with performance clearly superior to that of common *commercial off-the-shelf* (COTS) devices. For this reason, our design approach differs radically from the standard models of twenty years ago. We focus on innovative radiating solutions that overcome the limits of the current commercial offering, bringing research and technological innovation into a highly standardized sector.

4.2. The IoT sector and integrated antennas.

In recent years, integrated antennas have become widespread everywhere, from smartphones to the world of IoT, smart metering and advanced sensing systems. Although simulation software has become highly sophisticated, creating a perfect electromagnetic model is not the most efficient or time-saving approach, because it is often impossible to simulate with precision every single component present in modern devices, such as batteries and supercapacitors.

For this reason, it is essential from the outset to have a clear idea of where the antenna can perform best within the board or the device. This requires close collaboration with those designing the hardware, in order to identify in advance any critical aspects of the board that could compromise RF performance. Compared with the past, mechanical constraints are now much more stringent, and it is necessary to ensure compliance with precise parameters such as EIRP or TRP.

Consequently, one cannot rely solely on computer calculations: a mixed approach is required, combining simulation with practical testing in a properly equipped laboratory, where the antenna can be quickly measured in its real configuration. The most common mistake, in fact, is still designing the antenna as a standalone element, forgetting that the entire device influences its final performance.

4.3. Military antennas.

Antennas for military use cover a very broad field, ranging from long waves to microwaves. In recent years, some sectors have experienced renewed momentum: HF communications, for example, remain a fundamental strategic resource thanks to modern communication protocols.

Although this is a field that has unfortunately returned to the forefront of current events, military projects almost always represent the state of the art in technology. Developing an antenna in this domain is a highly demanding technical challenge. Since major manufacturers already offer established solutions for standard

requirements, customers turn to us precisely when they are looking for higher performance that commercial products are unable to guarantee.

In this context, a crucial step lies in the meticulous analysis of tender documents and technical specifications. It is often necessary to evaluate specifications with extremely demanding requirements, where inconsistencies between the electrical parameters indicated by system engineers may also emerge. One may think, for example, of the relationship between antenna gain and beamwidth, or of the "confusion" between the required XPD (*Cross-Polarization Discrimination*) value and the link loss due to polarization mismatch. Identifying these critical issues and distinguishing achievable targets from physically incompatible requirements is essential to ensure the feasibility of the project from the very early stages.

Operating in this sector therefore requires a solid technical background and a great deal of ingenuity: often the key to solving a complex problem lies in applying, in an original way, operating principles used in completely different frequency bands. It is precisely this ability to innovate, combined with a rigorous critical approach during the analysis phase, that allows us to offer unique solutions and distinguish ourselves from the competition.

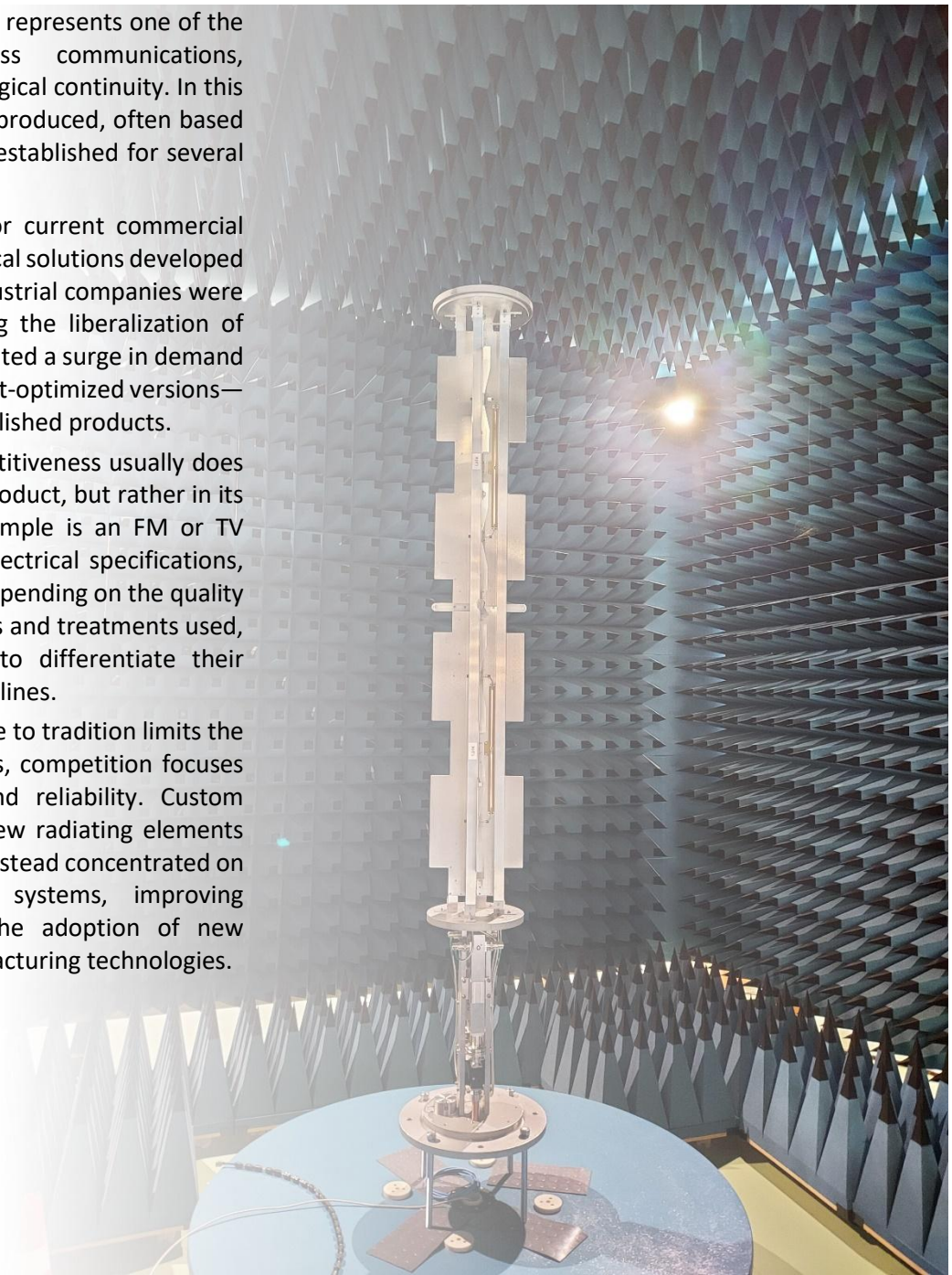
4.4. The civil and broadcasting sector.

The civil and broadcasting sector represents one of the historical pillars of wireless communications, characterized by strong technological continuity. In this field, "classic" antennas are still produced, often based on designs that have been well established for several decades.

It is not uncommon, in fact, for current commercial standards to trace back to technical solutions developed in the 1950s or 1960s. Many industrial companies were founded in the 1970s, following the liberalization of radio broadcasting, which generated a surge in demand and led to the introduction of cost-optimized versions—often derived from already established products.

In such a mature market, competitiveness usually does not lie in the exclusivity of the product, but rather in its manufacturing quality. One example is an FM or TV band splitter: given the same electrical specifications, the price can vary significantly depending on the quality of construction and the materials and treatments used, factors that allow companies to differentiate their offering across different product lines.

In this scenario, where adherence to tradition limits the exploration of new architectures, competition focuses almost exclusively on price and reliability. Custom design also follows this logic: new radiating elements are rarely sought; innovation is instead concentrated on the engineering of existing systems, improving construction details through the adoption of new mechanical solutions and manufacturing technologies.



4.5. Scientific research.

Over the years, collaboration with universities, research institutes and industrial partners has enabled us to develop custom antennas for cutting-edge fields: from electromedical devices to airborne SAR systems, from radiometry to bistatic radar for space debris monitoring.

In these fields, communication with the customer requires a rigorous “scientific approach,” based on highly precise specifications and terminology, in order to eliminate any ambiguity. Although the laws of electromagnetism are universal, each specialized domain adopts different conventions and priorities: one need only consider the distinction between gain expressed in dBd, typical of broadcasting, and dBi, which is standard in research. These interactions with the academic world represent technical challenges of the highest level.

Given the extremely stringent nature of the electrical specifications, custom design becomes a mandatory step, covering the entire development cycle: from the synthesis of the radiating element or array to the complete engineering and final realization.

5. Conclusions.

As we reach the milestone of our first twenty-five years, we wanted to present ElettroMagnetic Services in a different light, revealing the spirit that drives our “radiofrequency tailoring”.

We have consciously chosen not to transform ourselves into a large-scale production structure in order to preserve that **“atelier”** mindset—a technological craft workshop where the partners maintain direct and complete control over every stage of development.

Beyond the technical challenges addressed across the various sectors and the rigorous technocratic philosophy described, we wanted to highlight the human dimension that truly drives our daily work.

Behind every custom antenna and every complex project there are not only algorithms or state-of-the-art instrumentation, but people who have chosen to remain faithful to the idea of a technological craft workshop, where the relationship with the customer is built on transparency, direct dialogue and genuine passion.

We hope this brief article has allowed you to understand not only what we do, but who we truly are: a team that looks to the challenges of the future with the same curiosity and intellectual independence with which we began, many years ago.

All the information and experiences presented in this article are the result of the design, development, and production of custom professional antennas carried out by ***ElettroMagnetic Services Srl*** *using the* ***AntennaCustomizer*** *method.*

For questions, clarifications, or further information on this or other topics related to professional antennas, please contact ***bollini@elettromagneticservices.com****.*

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