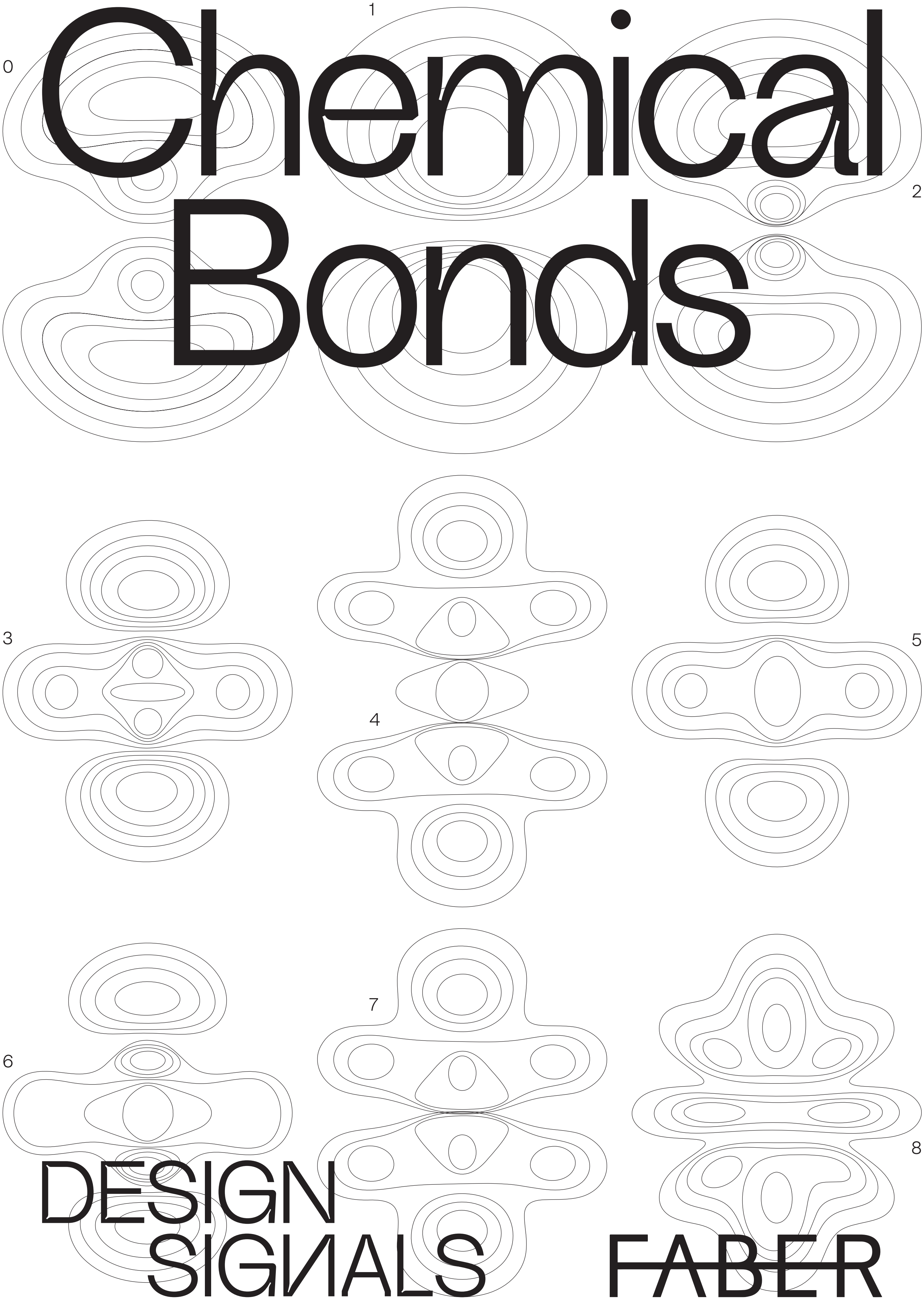
Chemical Bonds



DESIGN SIGNALS

FABER

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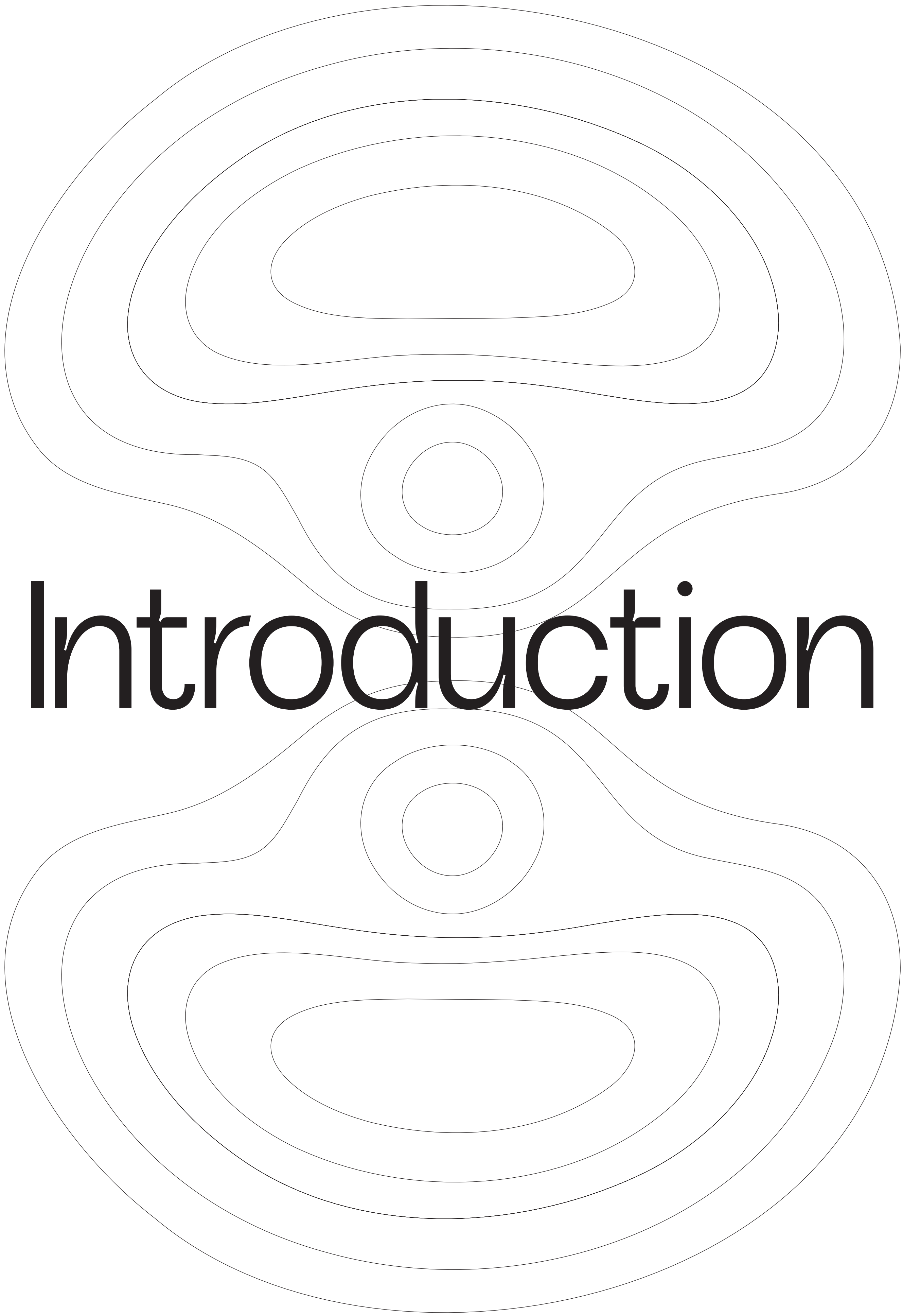
Introduction



0.1

Chemical Bonds

A reaction in progress

The third iteration of the Design Signals program explores the theme of Chemistry—an industrial sector deeply connected to Timișoara. Since the 1920s, chemistry has been one of the city's most powerful local industries, experiencing a significant surge in investment between 1978 and 1986 after Romania's planning committee identified it as a crucial driver for economic growth in the early 1970s (Ban, 2016).

FABER itself is located on a former industrial site with a long history in chemistry, being the birthplace of the AZUR chemical company in 1923. Soaps, detergents, resins, paints, and candles were produced on this site until the 1970s, when operations moved to the Buziașului industrial platform. Today, this same platform hosts more than 60 small businesses, artists, manufacturers, and our creative hub.

Oana Simionescu

While the major players in the sector have largely disappeared or shrunk considerably since the transition to capitalism, the city's industrial spirit persists in the mindsets and behaviours of its people, visible in both entrepreneurial and public spheres.

Because the story of the chemical industry is a national one, this year we expanded our scope, visiting more than 20 factories across the country. We built connections with people full of passion and nostalgia for a field that was once one of the most important economic engines of Romania.

Staying true to our mission of building bridges between industry and design, we brought designers with us into the factories. There, we inspired them with ingredients—raw materials and industrial by-products—to explore new potential and forge connections between disparate fields, factories, and domains.

This third episode is our most consistent yet and has unlocked possibilities we only dreamed of three years ago when we started. It brings our project to a level of maturity that is optimal for the exploration of our next two topics: agri-food and construction.

We invite you to explore the reality and potential of Romanian chemistry in relation to contemporary design in the pages of this publication.

BIO
Oana Simionescu is both architect and manager, constantly preoccupied with the future of the creative professions as well as with the way people and the built environment influence one another. She is the co-founder as well as the current director of FABER.

0.2

Chemical Bonds
A Curatorial Essay

Chemical processes form the basis of modern life. From the clothes we wear to the devices we touch, from the water we drink to the food we grow, chemistry is the silent infrastructure beneath almost every manufactured object and industrial system. Its influence is so widespread that it's easy to forget it's there—until it fails. Today, as climate targets drive a global push toward green transition, the chemical industry finds itself at a crossroads. On one side, it is an indispensable enabler of decarbonisation—providing the materials for renewable energy, batteries, insulation, electric vehicles, and more. On the other, it is one of the most resource-intensive, polluting sectors on the planet, slow to adapt, and structurally dependent on fossil inputs.

The contradictions at the heart of the chemical industry—its invisibility, its necessity, its entanglement in both progress and harm—are not just technical, but political. The sector is increasingly shaped by multinational actors, rigid regulatory regimes, and globalised standards that often overlook local capacities or knowledge. It is one of the most outsourced and standardised sectors in Europe, and its logic is not easily legible to those outside of it.

This is particularly true in Romania, a country rich in geological resources. Once home to fully integrated chemical platforms—where research, production, and policy were inseparably linked—the country now hosts a patchwork of fragmented sites: partial processing units, logistical centres, and distribution hubs that remain disconnected from each other and from national policy. Much of the innovation, ownership, and strategic vision has shifted elsewhere. What remains, however, is something no less significant: a network of skilled workers, researchers, technicians, and engineers who continue to sustain an industry despite its constraints.

Martina Muzi

A Particular Geography

Timișoara offers a specific and situated lens through which to observe these dynamics. As a city shaped by manufacturing, engineering, and extractive industries—many of which remain active but undervalued—it is both context and method for the ongoing inquiry that is Design Signals. Since 2023, during the city's year as European Capital of Culture, the research and design platform has treated Timișoara as a site of encounter: between cultural practice and industrial production, between inherited infrastructures and emergent knowledge. The approach has always been infrastructural: how do invisible systems materialise a place, and how can design help trace their effects and open them to encounter?

Each edition of the programme investigates a different sector—outsourced manufacturing, textiles, and now the chemical industry. The choice of sectors has not been thematic or symbolic. They are areas where design is already embedded—often invisibly—within systems of production, training, and logistics. And they are industries that, despite their apparent decline or obscurity, still hold forms of knowledge, expertise, and relevance that can be reactivated. The intention is not to use design to fix what is broken, but to map what is already there, to prototype new relationships, and to test how to hold open spaces where complexity is made visible and dialogue becomes possible.

My role as curator is to create a provisional infrastructure for collaboration—one that, even if temporary, can fill gaps in the system and allow for independent research, policy, design, and local expertise to converge and explore alternative paths. This is not about glorifying independence. It's about understanding and supporting new forms of interdependence—through nurturing connections between agents that would otherwise remain unlinked.

Each edition operates as an episode within a larger structure: sequential, cumulative, and generative.

> Curating these episodes becomes a way of building a narrative over time—one that gains energy as it moves, like a dynamo.

Timișoara, in this sense, is not a backdrop, but a geographical particular: a context whose specificity reveals wider dynamics of production, regulation, and peripheral position-making within Europe. By working from within, we begin to see how nuance, resistance, and alignment emerge not despite the periphery, but through it.

Chemistry as Lens

The chemical industry became crucial for Design Signals to address because it underpins both of the previous sectors—automotive and textile—as well as future ones, including agriculture and real estate.

> From the coatings on walls to the medicines we take, from fertilisers that grow our food to the polymers in every phone or shoe, chemical processes are embedded throughout.

It is also a key site of the green transition: copper extraction, hydrogen fuels, and materials transformation are central to the EU's climate agenda. But perhaps most importantly, it is a sector through which Romania's industrial position within Europe becomes especially visible—revealing both historical continuities and structural asymmetries in the present.

Romania is often treated as a standardised periphery—a region shaped to meet the regulatory and infrastructural expectations of the European centre, rather than to develop its own capacity. But this project pushes against that framing by insisting on the geographical particular of the so-called periphery: the skills, expertise, and forms of care that persist within local infrastructures. These are not remnants of a past system—they are active, if often undervalued, parts of today's industrial ecosystem. By working within these specifics, the project challenges the idea of the periphery as generic or passive. What we see instead is a system in which innovation struggles to travel: companies operate in isolation, research centres are disconnected from production, and public investment remains limited. Innovation does not disappear; it becomes structurally trapped.

This fragmentation is not accidental. It is a result of historical processes: the dismantling of the socialist-era platforms that once integrated research, production, and policy; the sell-off or closure of key infrastructure; and the consolidation of value around foreign-held patents and logistical hubs. At the same time, the chemical sector is being reanimated by the green transition and its material demands. New standards, driven by EU regulation and global investment, are reshaping what chemical production looks like—and who gets to participate. In this way, the force of global capitalism is double-edged: it fractures national infrastructure while also creating moments of strategic urgency that may open new possibilities.

It is precisely within this tension that design becomes relevant—not to offer resolution, but to hold space for inquiry, and to make visible the dynamics at play. But for design to take on this role, it must be grounded in conditions that are real, not speculative. This requires research—not as academic framing, but as infrastructural groundwork.

Research as Starting Point

Each edition of Bright Cityscapes begins with a commissioned research report, not a curatorial concept. This decision is central to how the programme works. Research sets the parameters for engagement: it identifies actors, gaps, and frictions; it gives form to otherwise invisible systems; and it provides a foundation for collaborations between designers, engineers, institutions, and publics. It is a way of curating conditions, rather than outcomes.

For Chemical Bonds, sociologist and data analyst Norbert Petrovici returned as research lead, mapping the post-socialist evolution of Romania's chemical industry. Once composed of vertically integrated platforms—where extraction, research, production, and distribution happened together—the sector is now fragmented across disconnected sites. Some companies retain the capacity to develop and patent new materials. Others perform only production or distribution functions, often for foreign-owned firms. What appears as a network is in fact a set of isolated units, unable to build knowledge collectively or act strategically across policy, industry, and research.

> This disconnection is not due to a lack of material resources. Romania's geological composition makes it extraordinarily rich in extractable substances—salt, copper, limestone, rare metals. But without the infrastructure to integrate these materials into production and innovation ecosystems, that richness remains latent. Even where potential exists—for example, in bioplastics—there are few mechanisms to translate technical capacity into viable industrial processes.

Petrovici's research doesn't simply describe what's broken. It maps the structural conditions that shape the sector: the gaps in infrastructure, the disconnection between research and production, the fragmentation left by privatisation. It forms the foundation for curatorial work that does not impose themes, but curates conditions—opening gates into industrial sites, building relationships with workers and institutions, and identifying the points where something else might be possible. This is not research for citation or extraction. It's part of a longer process of producing knowledge that stays.

Mirroring the Ecosystem

Knowledge that stays means more than producing reports. It's about creating proximity—between sites, people, and disciplines—and building points of contact for future collaboration. This phase of the project, which we refer to as Mirroring the Ecosystem, involved over 20 visits across Romania, where we quite literally opened the gates to extraction sites, sprawling plants, mountain ridges, and logistics corridors. It moved beyond the boundaries of Timișoara—but what is a city, if not its interdependencies?

> We didn't visit these sites to extract content for an exhibition. We went to start conversations.

These encounters—with engineers, workers, managers, and landscapes—produced an evolving archive of interviews, photographic essays, and material samples. Together, they help disclose dynamics that are often obscured by scale, regulation, or standardisation: how risk is distributed across space; how maintenance happens without investment; how knowledge is practiced even when it isn't formally recognised.

When this material enters the exhibition space, the chemical industry shifts from subject to context—something ongoing and embedded. The exhibition takes place in the former Azur factory, once a site for pigment and varnish production, still marked by its industrial past. The furniture is built from local materials—pipes, tiles, adhesives—sourced through the same production networks we've studied. The venue and furniture aren't simply aesthetic choices, but representative of the same chemical system that is invisibly involved in materialising so much of daily life. The exhibition becomes a continuation of the research: temporary, partial, materially and geographically situated. Timișoara is not a backdrop—it is a city shaped by these infrastructures.

Knowledge that stays is not just a principle—it's the starting point for how the curatorial process unfolds. It means keeping research in motion, embedding it locally, and allowing it to evolve into collaboration.

This approach is not about reorganising information into fixed displays, but about curating the conditions for new engagements to take place. It is a strategy of connecting points, of opening space for proximity—between people, tools, institutions, and policies. Documentation is part of this strategy: not as passive evidence, but as an active step in building relationships that might allow other forms of design to emerge. The goal is not to fix a system from outside, but to navigate it from within—amplifying what is already there, and making space for new interdependencies to take root.

Designing as Amplification

In addition to the research and site work, an open call invited designers to respond to the complexities of Romania's chemical sector—not by illustrating its problems, but by proposing ways to engage with its realities. The selected projects each embed themselves within existing processes, institutions, and materials. Each begins with a question of access: how to enter a system shaped by patents, regulation, and fragmentation—and how to work within that complexity without flattening its nuances.

Developed in close collaboration with local partners—ranging from bioplastics producers to extraction sites and independent researchers—each project explores a different relationship to chemistry.

One treats salt as both an industrial mainstay and a bodily source of care, producing a therapeutic device that reflects the dual logics of wellness and production. Another pushes the potential of locally made bioplastics, asking how alternative materials might take shape across everyday uses and speculative design. A third produces ceramic surfaces from mineral waste, allowing heat to reveal the composition of residual materials—speaking to both the physical content and the secrecy that surrounds the industry. The fourth examines galvanisation processes as a form of industrial protection that is both sacrificial and vital.

None of these projects attempts to redesign the chemical industry. Instead, they work within its constraints to amplify overlooked knowledge, connect fragmented processes, and make visible the dependencies that quietly shape our material world. They function as rehearsals for interdependence—temporary alignments between design, production, and research that test what kinds of engagement are possible under conditions even slightly different from those we've come to accept as standard.

Together, they extend the curatorial aim of building provisional infrastructures: not finished systems, but situations where different agents can meet—however briefly—and where new forms of collaboration can be prototyped.

Journalism as Design Method

One of the new collaborations facilitated in this edition is between journalism and design. The choice was deliberate. The chemical industry sits at the heart of the green transition, yet the transition itself has not happened—it is a horizon, filled with both urgency and uncertainty. How, then, to talk about an industry whose future is being contested in real time, and whose impact is both intimate and systemic?

Journalism was turned to as a method for navigating this extremely delicate and central social turning point. Journalists have the capacity to construct narratives around case studies and contexts, distilling complexity into stories that reveal key nuances often lost in technical reports or conceptual communication. By working in conversation with designers—who bring methods of image-making, visual anthropology, and spatial translation—these investigations become more than reportage. They test how systemic issues might be articulated in ways that are publicly legible, emotionally resonant, and open to critique.

The result is not prediction, nor solution, but perspective: an attempt to visualise and interrogate the chemical industry's role in shaping possible futures. In doing so, the exhibition positions journalism as a design method—one that extends the curatorial aim of making hidden infrastructures visible, and opening them to public debate.

Education and Continuity

If journalism expands design into the public sphere, pedagogy extends it forward in time. Each edition of Design Signals includes Young Matters, a summer school where design students from different faculties and tutors from Romania and abroad collaborate. These workshops are not speculative exercises but context-driven engagements: chemistry is explored where it is lived, whether by prototyping visualisations that make air quality legible, tracing copper through histories of extraction and energy, or mapping the city's chemical ecologies through embodied, sensorial practices.

Continuity here is not about repeating a format, but about investing in how knowledge carries on. Pedagogy becomes a design method in itself—shaping future practitioners, embedding case studies and methods into curricula, and creating institutional exchanges that can be taken up again in years to come.

Working across local and international contexts, students and tutors build networks that move beyond a single project, seeding perspectives that may reappear elsewhere.

In this sense, Young Matters functions as a pedagogical form of 'paying it forward': embedding methods and collaborations that can be reused in curricula, carried into future practice, and kept alive by the next generation of designers.

Curatorial Practice as Provisional Infrastructure

Across its episodes, Bright Cityscapes has not sought to deliver solutions, but to construct the conditions in which other possibilities can be glimpsed. Each edition accumulates: first automotive, then textiles, now chemistry. Together they trace not only industries, but a methodology—curating as a way of opening gates, disclosing dynamics, and creating proximity between agents that would otherwise remain apart.

This curatorial practice is provisional by design. It fills gaps in the system with temporary infrastructures that enable research to circulate, collaborations to take shape, and knowledge to stay.

It treats documentation, conversation, and pedagogy as active tools—ways of amplifying what already exists rather than imposing new frameworks from above. In this sense, designers become agents of amplification, making visible the values embedded in interdependence, and showing how even within tightly standardised systems, alternative connections can be rehearsed.

To curate here is also to move between scales: from the micro story of a residue in a glaze or a breath in a salt chamber, to the macro forces of patents, policies, and global standards. This jumping between scales is not ornamental—it is the only way to understand how the periphery is produced, contested, and reimagined. It shows how the geographical particular of Timișoara can reveal wider dynamics of capitalism's double edge: fragmenting local infrastructures while also opening strategic opportunities within the green transition.

Curating as provisional infrastructure does not close systems or resolve contradictions. It holds them open. It builds spaces where research, design, journalism, and education can converge, however briefly, and where overlooked practices and knowledge can gain resonance. These are not conclusions, but beginnings: signals of how design might continue to act—across sectors, disciplines, and scales—not as a promise of change, but as a practice of staying with complexity.

BIO

Martina Muzi is a designer, curator, and educator, and leader of the Studio Technogeographies BA programme at Design Academy Eindhoven. She is the curator of the Design Signals program, of which Chemical Bonds is the third episode.

Groundwork

1.1

The Stalled Catalyst

An Interview with Norbert Petrovici on Romania's Chemical Industry

In his report 'Learning regimes and capacity formation in an advanced peripheral economy: Romania's chemical industry', sociologist and researcher Norbert Petrovici plays the role of economic geographer, exploring the stalled potential of Romania's chemical industry, drawing on extensive research and interviews with key players from legacy plants to multinational outposts. In this interview, he speaks about the sector's critical yet invisible role, the "residual knowledge" that persists from its socialist past, and how its future is inextricably linked to the green transition and strategic state policy, arguing that its true value lies not in nostalgia but in its unrealised capacity for foundational innovation.

Your research moves from Romania's automotive and textile industries to its chemical sector. What drew you to this transition, and why is the chemical industry a critical subject of study now?

NORBERT PETROVICI
The chemical industry was absolutely central during socialism, a technological linchpin that enabled other sectors. Today, it's economically significant yet largely overlooked—*visibly invisible*. It's structurally stuck, grappling with its socialist legacy while being crucial for the future. The green transition, the shift from a petro-based economy, and current geopolitical energy tensions are impossible to imagine without chemistry. It's a core sector. Yet, unlike automotive, which transitioned successfully into global value chains with technological upgrading, chemistry has not. I wanted to research why it failed to find its footing.

For our readers who may be unfamiliar, what does Romania's chemical industry look like today?

Its structure reveals its history. Under socialism, it was predominantly B2B, providing raw materials for other industries. Today, it still retains that B2B core but has shifted slightly from basic chemicals to more technical intermediate products. However, it rarely reaches the final consumer good. This is highlighted by a massive trade imbalance: we import twice as many chemical products as we export. The Romanian market is flooded with imported cosmetics, plastics, and intermediates needed for our own automotive and textile sectors. The sector has capacity, but it's not positioned to cover internal demand, let alone drive innovation.

Let's go back to that socialist inheritance. How was the industry structured, and what kind of expertise was built into it?

It was built on vertical integration—controlling everything from mineral extraction to the final product. This required a specific, hierarchical corporate structure. But the key difference was the intense need for technology and learning. Chemical processes couldn't be easily experimented with; patents were controlled by Western multinationals. Furthermore, many products had dual uses (civilian and military), meaning critical knowledge, like specific catalysts or mixing formulas, was often locked away by Western powers.

This forced the state to develop a dense, robust national innovation system. There was a vast network of about 25 national research institutes, plus laboratories within every factory, all dedicated to reverse-engineering Western patents and adapting technologies to local inputs. When a licensed factory was installed, often by German companies like Siemens or Zimmer, the impulse was to train local engineers to fine-tune and operate it independently. Factories even developed their own mechanical workshops to produce spare parts, creating a deep, practical, organizational knowledge.

What happened to this extensive infrastructure after 1989?

It experienced a severe institutional collapse. The national institutes limped along until around 2002 but without investment. When European grants arrived, they prioritised knowledge production for publication, not innovation for deployment. The critical link between the research institute and the factory floor was severed. The on-site factory labs were decimated; where 200 engineers once worked, you might find five today.

This collapse created a new dependency. Today, if a local company develops a new process, it must often go to Germany for expensive verification and licensing because the national capacity for this is gone. To truly innovate and scale, they need to partner with a multinational that has the capital and institutional power to handle global IP licensing. The system that once enabled autonomous adaptation now funnels innovation back to multinational headquarters.

You use the powerful concept of "residual knowledge." Can you give an example of a plant still running on this inherited expertise?

Certainly. The most successful residual knowledge lies in the mechanical factories that were within the plants. These teams, skilled in operating, repairing, and adapting machinery, were sometimes able to spin off and become players in engineering design and installing factories for multinationals, leveraging their deep understanding of local adaptation.
Another form is the knowledge of vertical integration. Managers and engineers who understood the precise sequence of inputs needed for complex production tried to replicate these business verticals. Companies like Chimcomplex or those in the food sector have attempted this, with varying success. This inherited expertise is a form of organizational memory that is both a residual of the past and a precarious resource for the present.

Your work describes Romania's re-integration into global markets as a form of dependency. Can you explain how this "lock-in" works?

The key difference lies in where research and development (R&D) and intellectual property (IP) are controlled. In automotive, R&D can be decentralised geographically. In chemicals, it is highly concentrated at multinational headquarters because it is incredibly expensive. This means Romania is often integrated only through low-autonomy roles: production outposts that follow strict standard operating procedures or packaging hubs.

There are exceptions, like in generic pharmaceuticals where companies repurpose expired patents. But even this is a form of dependency. We export generics, but we import twice as much in higher-value, specialised medical products. The learning that happens in these integrated roles is about cost reduction, particularly energy input, not about groundbreaking innovation. The high-value, IP-generating work remains elsewhere.

You've developed a typology of five "learning regimes" in these companies. Without getting bogged down in jargon, what does this typology reveal?

It reveals a spectrum of autonomy and innovation. On one end, you have firms that are mere executors—production outposts or packaging hubs with no real autonomy or IP. On the other, you have a few residual legacy firms and generic pharma companies that still attempt some domestic R&D, trying to innovate around energy efficiency or process adaptation.

Our initial typology was too rigid. Through ongoing fieldwork, I've found surprising learning even in unexpected places. For instance, a company classified as a mere sales distributor might be innovating in marketing, developing IT tools to teach clients how to use chemicals, or even inventing new compounds through consultancy. The landscape is more fluid, but the central problem remains: the learning is often insular, fragile, and reliant on individual experts. If one key engineer leaves or passes away, an entire knowledge domain can be lost because it's stored in people, not in institutionalised, replicable processes.

This feels like a deeply human story. Beyond structures and systems, what is the human cost of this structural stagnation?

Human geography is different from automotive. Chemical plants are often massive, contaminated sites in city centers. They are no longer mass employers but have become real estate assets. Their future is now part of a political economy of urban development, contamination cleanup, and deliberative democracy—a form of industrial heritage that is deeply entangled with strategies of urban planning.

Yet, within the companies that remain, I was struck by the passion. I spoke with doctors and engineers with a real pioneer, almost "cowboy" mentality—a desperate, energetic drive to be the first, to try and catch up, to survive against immense barriers. There is a palpable will to innovate.

If you could fix one thing within the triple bond of policy, industry, and research, what would unlock the potential you see in these people?

The state is the most important and currently absent actor. The market alone cannot de-risk knowledge production in this sector. The state must act as a catalyst to re-establish those linkages. The global economy still operates on verticals, and for chemicals, relying on imported inputs makes products uncompetitive. For the green transition—which is utterly dependent on chemical innovations for everything from solar panels to semiconductors—having a nationally bounded production network isn't a socialist relic; it's an economic necessity. The state must create conditionality in aid, foster ties between cutting-edge European initiatives and local industry, and strategically support the integration across business verticals. Without this catalytic role, the immense energy and passion of those on the ground will remain trapped, and the industry's potential as a catalyst for a new future will remain unfulfilled.

1.2

Chemical Trajectories

Hidden Forces That Shape Our Industry

Norbert Petrovici
with Krisenstab

The Chemical Trajectories project extends a broader research inquiry into how Romania's chemical industry evolved from the socialist period's state-coordinated specialisation toward the fragmented, trade-dependent structures of the 2000s. By mapping each sector's position in terms of product complexity and export-import balance, the visualisation reconstructs how industrial capacities advanced, regressed, or disappeared across six decades of integration into global markets.

The analysis builds on a study of learning regimes in the chemical sector, structured around a fivefold classification of knowledge accumulation: execution, technical-task, residual-autonomous, commercial-relay, and interface. These regimes can be read as interpretive coordinates for the visualisations. They trace how different forms of learning, from standardised replication to adaptive repair and cross-domain experimentation, have accumulated within Romania's industrial fabric. In the charts and tiles, these regimes appear as patterns of motion and constraint: sectors that move upward in complexity signal temporary autonomy, while those oscillating along the import axis reveal structural lock-ins.

Using international trade data from 1960 onward, each business vertical is represented on a scatter-plot graph according to product complexity and export-import balance. The resulting visualisations animate the shifting trajectories of industries over time: while some advance toward higher technological sophistication and become part of Romania's export landscape, others remain structurally dependent on imported inputs.

A second layer of visualisation presents individual chemical products in a series of tiles. Each column corresponds to a business vertical, like agriculture and fertilisers, automotive chemicals, and plastics, tracing how Romania's industrial position evolved between 1960 and 2020. Each tile captures both exports and imports, revealing the dependency structures embedded in everyday materials. The fertiliser tiles show the persistence of import reliance for phosphatic and potassic inputs despite localised formulation capacity. The automotive tiles document the rise of intermediate goods, from anti-knock additives to tires and engineering plastics, illustrating how Romania became an assembly node within global value chains. The plastics tiles highlight how synthetic materials, once peripheral, now function as infrastructural substances linking manufacturing, logistics, and consumption. Together, the tiles act as temporal cross-sections of economic integration, translating trade data into tangible material form.

The project makes visible the hidden logic and economic contingencies that continue to shape the chemical sector through asymmetrical modernization. While a few branches have advanced toward higher technological complexity, most remain locked in low-value activities, reliant on imported inputs and volatile external demand. This structural dependence has limited the accumulation of local know-how and constrained the formation of autonomous innovation regimes.

Placed within the exhibition, these visualisations provide an analytical background for the other works. They expose the macroeconomic logic underlying the material and social processes documented through interviews, factory images, and design interventions, from residues and biomaterials to ecological repair, showing how chemistry underpins both industrial transformation and everyday life. The installations can be approached as variations of learning through matter, each translating dependency and invention into distinct material and sensory registers.

BIO

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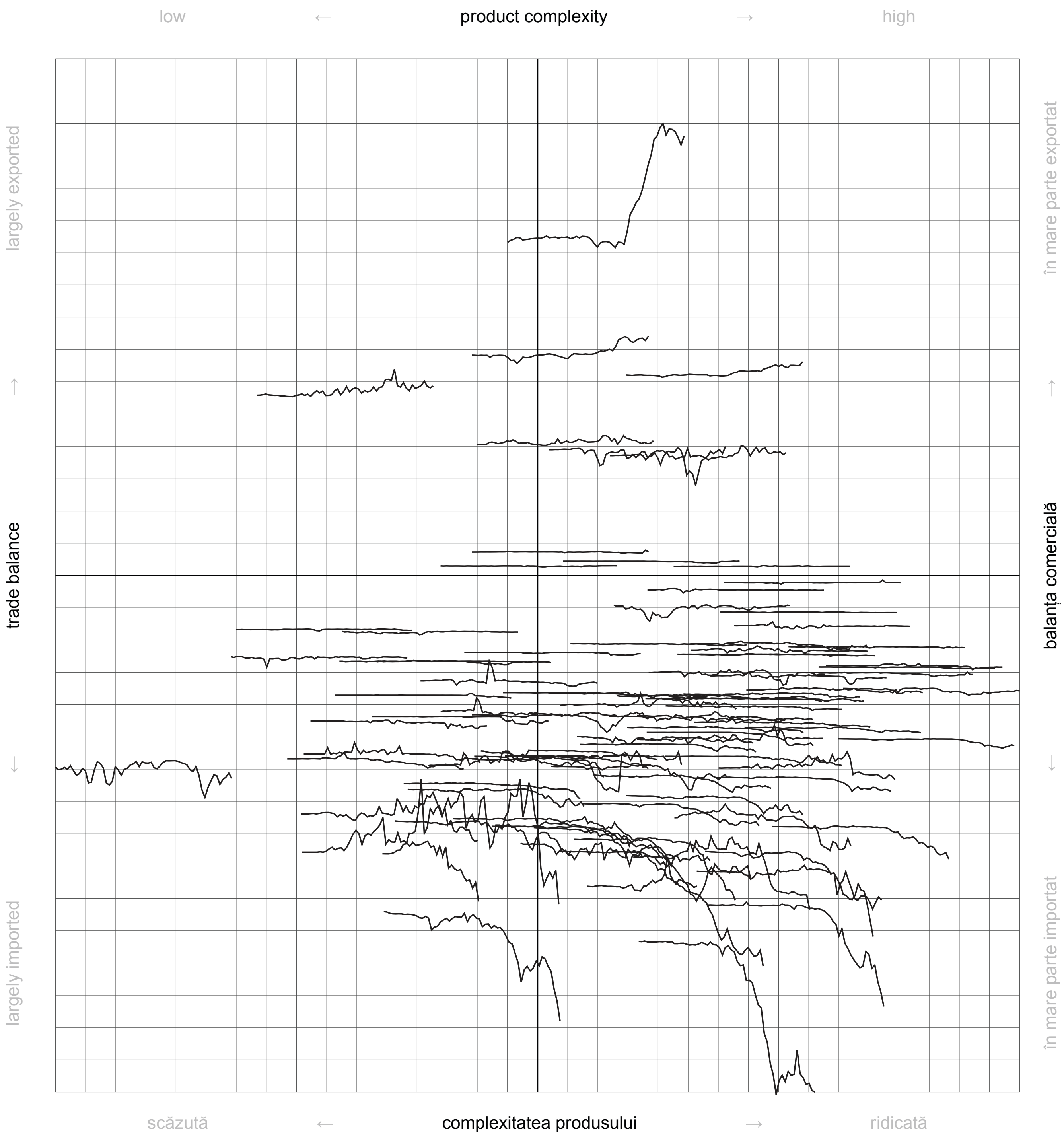
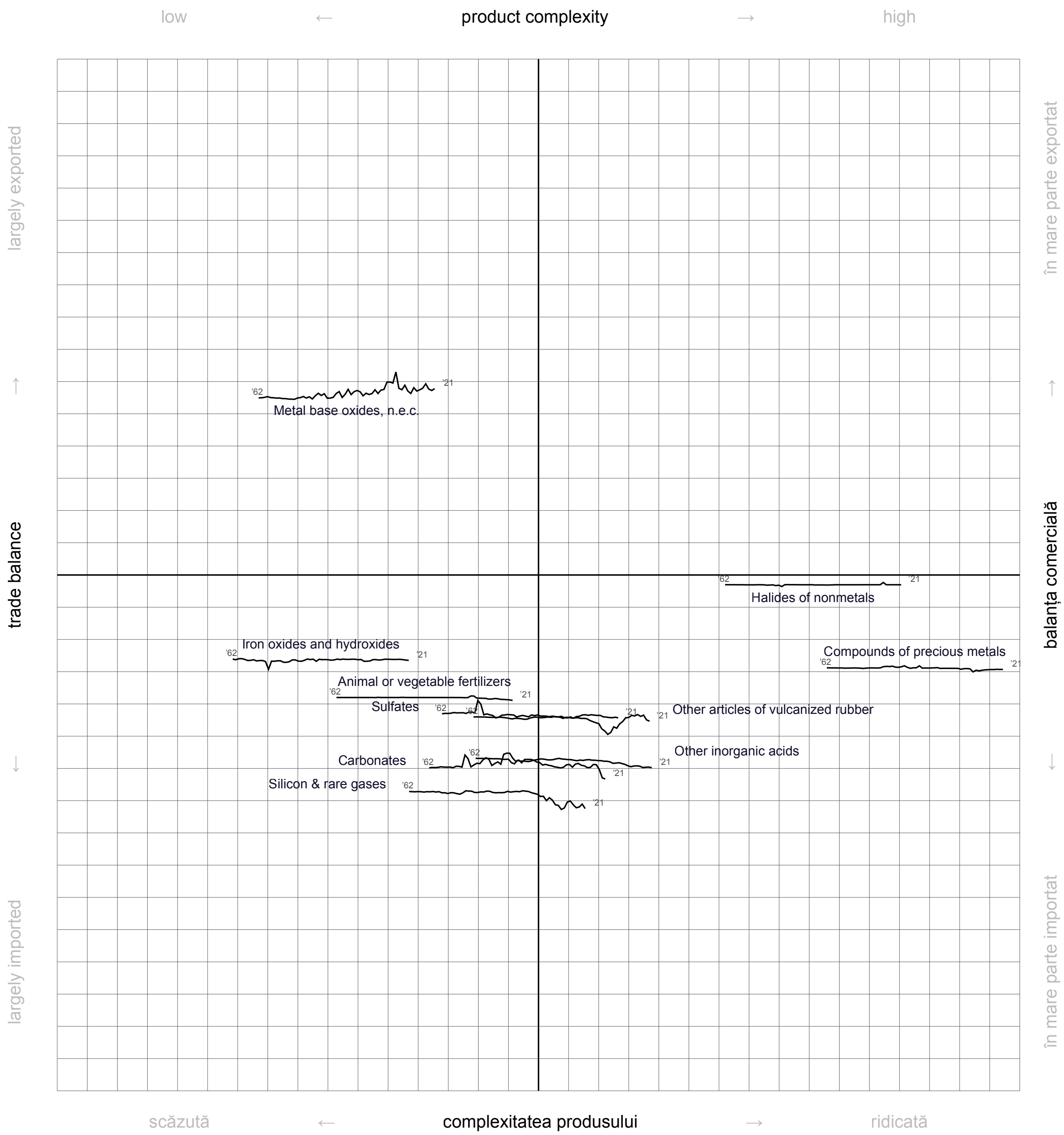
Krisenstab is a Berlin-based information design studio founded by Fidel Thomet, Giacomo Nanni, and Julian Peschel. They specialise in creating hybrid interfaces for complex datasets, enabling new forms of exploration and understanding for cultural institutions, researchers, and journalists.



Romania's chemical industry shifted from high-volume, low-complexity exports in the socialist era to import dependence after 2000. Branches such as automotive chemicals, rubber, and plastic packaging became export pillars. Other sectors lost their edge or stayed import-driven. The chart shows the link between product complexity and trade balance (exports–imports).



Anorganic Processing Inputs
Romania relied on mineral resources and inorganic chemicals for heavy industry. After 1990, extraction and refining declined, while imports rose. Low-complexity products such as caustic soda and cement remain, but with uneven competitiveness. Today these branches act as support sectors rather than export drivers.

CARBONATES
Widely used in glass manufacturing, ceramics, and environmental applications (e.g., flue gas treatment). Romanian use is possible in cement and lime production (especially Holcim/Lafarge sites), and possibly in water softening or plastics fillers.

COMPOUNDS OF PRECIOUS METALS
These high-value compounds are used in catalysts, electronics, and chemical synthesis. In Romania, integration is limited to niche industrial processes (e.g., automotive catalytic converters, dental and medical devices), often in MNC subsidiaries or R&D-oriented firms.

HALIDES OF NONME TALS
These are used in optics, pharma synthesis, and metallurgical refining. In Romania, their use is more specialised, in pharma intermediates, glass coating, or electronics-related processes (where iodine and fluorine compounds are involved).

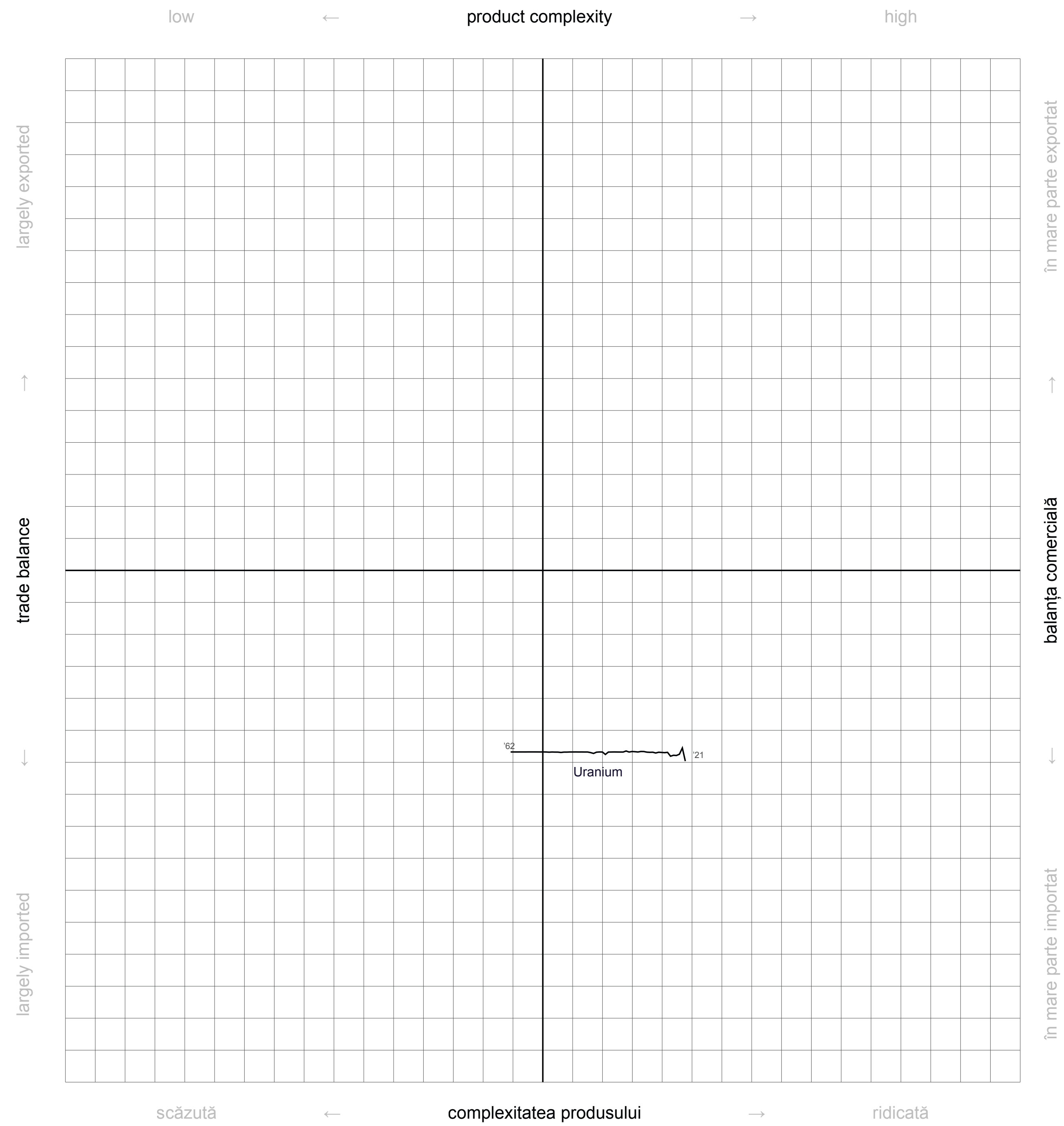
IRON OXIDES AND HYDROXIDES
These compounds are widely used as pigments (in coatings, plastics), polishing agents, and metallurgy additives. In Romania, they are integrated into industrial coating processes and possibly in metallurgy (e.g., casting and sintering), particularly in secondary towns with legacy industrial platforms.

METAL BASE OXIDES, N.E.C.
These oxides serve as fluxes, catalysts, and ceramic additives. Their integration in Romania is expected in metallurgical processing, glass production, and chemical formulations in basic industries, especially in industrial clusters like Hunedoara, Galați or Târnăveni.

OTHER INORGANIC ACIDS
Inorganic acids (e.g., hydrochloric, nitric, sulfuric) are backbone chemicals for a range of industrial operations. Romanian demand comes from chemical synthesis, metal processing, fertilisers, and cleaning agents. These are foundational in multiple verticals and imported in large volumes.

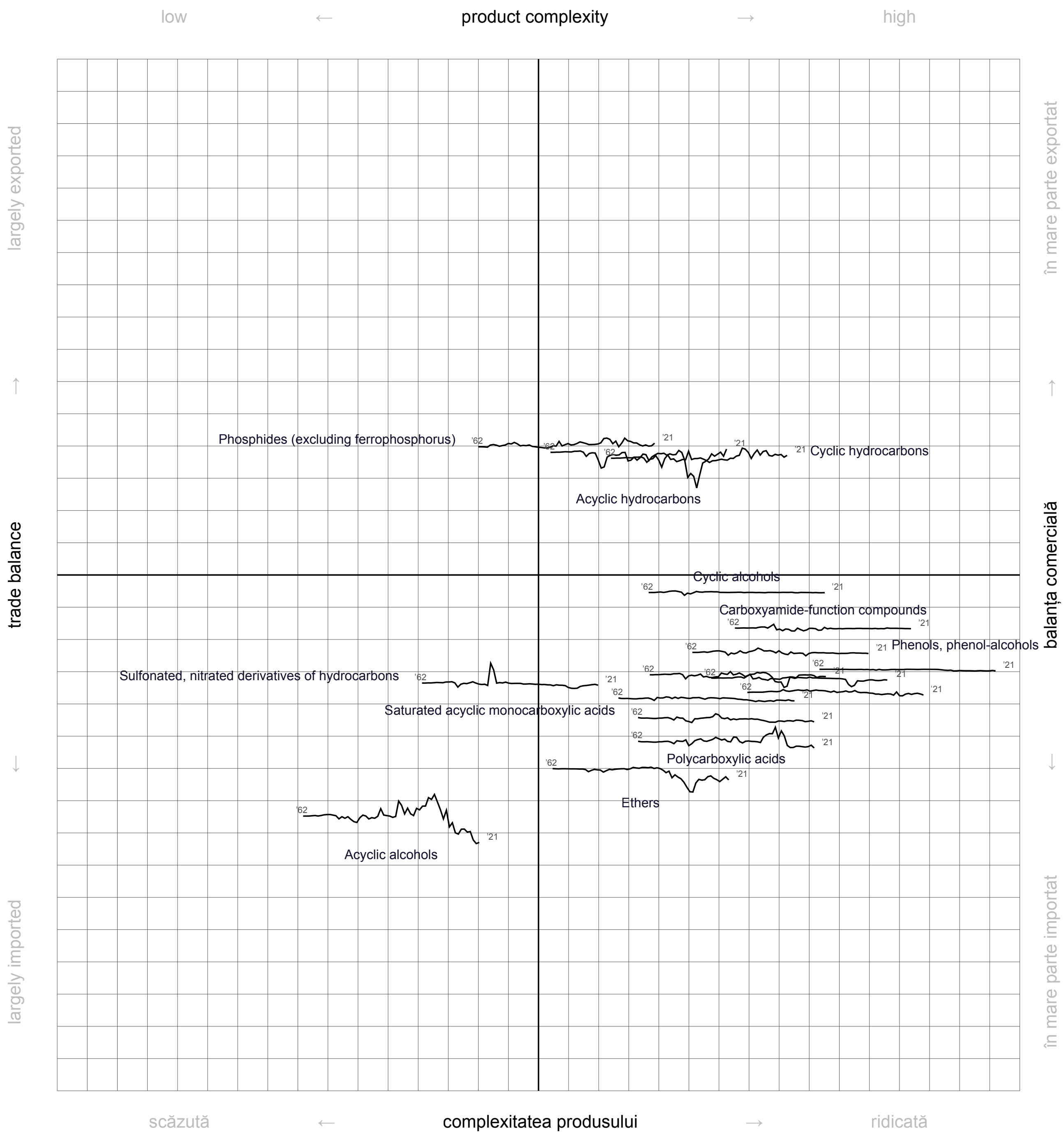
SILICON & RARE GASES
These inputs are essential in electronics, metallurgy, and specialty glass. Romania may use silicon in aluminum alloy production or sealants, while rare gases (like argon, neon) are typically used in high-tech manufacturing, medical devices, and lighting, imported and used in small but high-value sectors.

SULFATES
Sulfates are used across sectors, from fertilisers to dyeing, tanning, and metal treatment. In Romania, they serve as intermediate inputs in textile dyeing, wastewater treatment, and electroplating, notably in mixed-use industrial parks with chemical or textile activity.



Nuclear and Radioactive Materials
During socialism, Romania invested in nuclear research and reactors.
After 1990, the field continued around the Cernavodă plant but without large trade flows. It is defined by technological dependence and strict international regulation, a strategic sector rather than a commercial one.

URANIUM
Romania operates Cernavodă Nuclear Power Plant. Imports of uranium (in processed forms) are managed by state-owned companies under strict regulation, and form part of the national energy infrastructure.



Organic Petrochemical Intermediates
Petrochemicals was a key industry, with large industrial complexes.After 2000, many closed down. Romania remained a net exporter of several products, such as acyclic and cyclic hydrocarbons or phosphides, used in plastics, rubbers, paints, and alloys. Although more complex, volumes declined and imports increased, a sign of weakened industrial specialization.

ACYCLIC ALCOHOLS
Used in solvents, plasticisers, and coatings. They enter Romanian chemical value chains in coatings and adhesives, especially in export-oriented clusters.

ACYCLIC HYDROCARBONS
Basic inputs for synthetic chemistry, fuels, and plastic pre-cursors. These are foundational in petrochemical refining chains and may be processed or re-exported via hubs like Pitesti or Midia.

AMINE-FUNCTION COMPOUNDS
Used across agrochemicals, pharmaceuticals, and rubber processing. Romania's consumption is connected to fertili-zer additives and fine chemical formulation.

CARBOXYAMIDE-FUNCTION COMPOUNDS
Found in pharmaceutical and polymer sectors. Romania may process these compounds into formulations or coatings.

PHOSPHIDES
(EXCLUDING FERROPHOSPHORUS)
These are used in specialty metal alloys and as precursors for semiconductors or agrochemicals. In Romania, their use is limited to niche industrial applications or research imports.

POLYCARBOXYLIC ACIDS
Used in polymer synthesis (e.g., PET), detergents, and water treatment. Romanian integration is expected via plastics and textile finishing.

SATURATED ACYCLIC MONOCARBOXYLIC ACIDS
Includes formic and acetic acids, used in food processing, textiles, and pharma. Romania's agro-processing and textile sectors rely on imports.

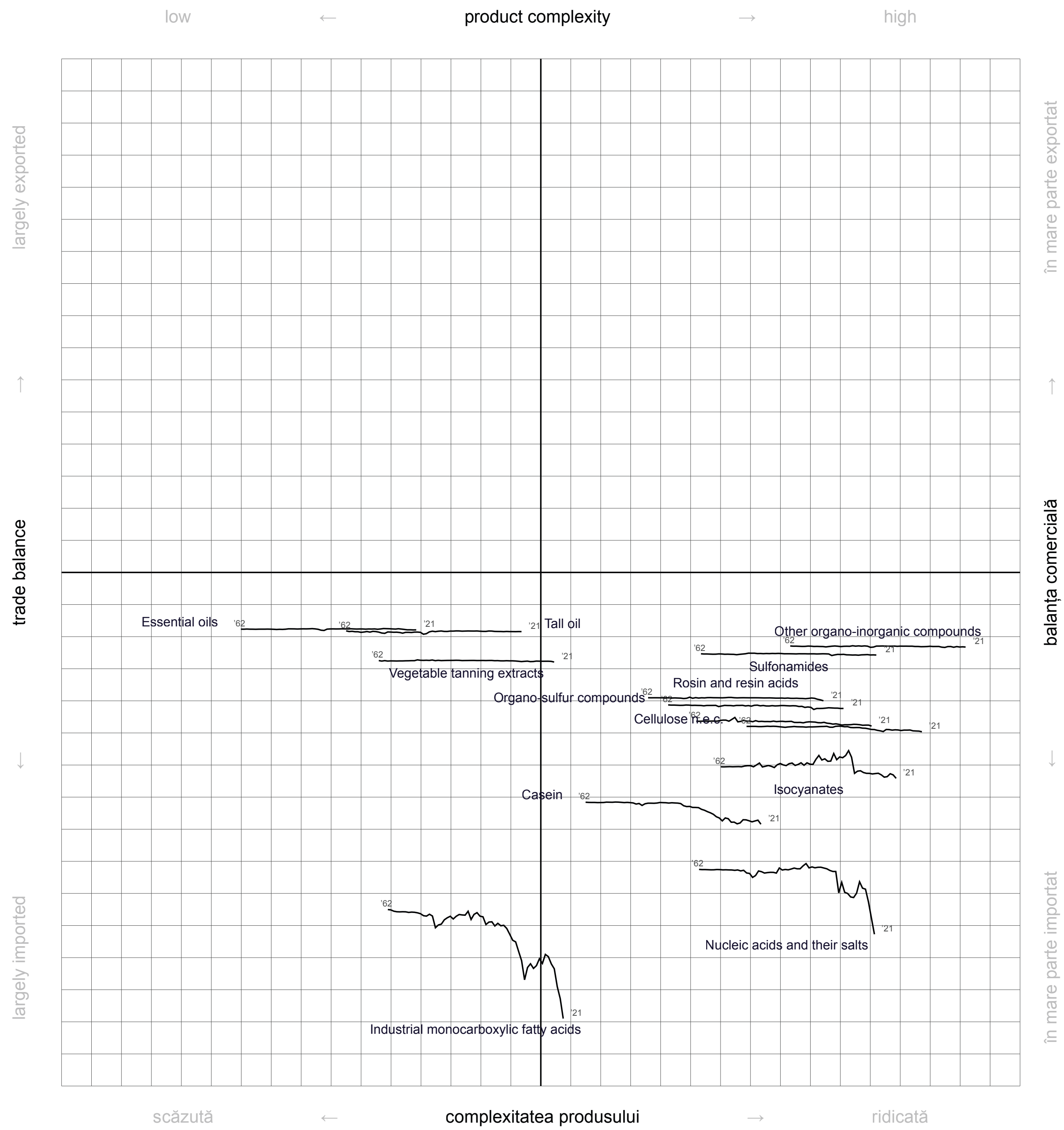
SULFONATED, NITRATED DERIVATIVES OF HYDROCARBONS
Core building blocks for surfactants, dyes, and explosives. In Romania, they are integrated into detergents or potentially explosives manufacturing (e.g. Făgăras).

CYCLIC HYDROCARBONS
Used in synthetic rubber, resins, and solvents. Romania may integrate them in tire manufacturing and adhesives (especially near Timișoara and Slatina).

ETHERS
Used as solvents or fuel additives (e.g., MTBE). Romania imports ethers for chemical synthesis and potentially fuel blending.

HALOGENATED DERIVATIVES OF HYDROCARBONS
These are reactive intermediates in pharmaceuticals, agrochemicals and polymers. Romanian imports feed into batch chemical processing or fine chemistry.

PHENOLS, PHENOL-ALCOHOLS
Important for resin production (e.g., phenol-formaldehyde), dyes, and pharmaceuticals. Romania's use is in adhesives and construction materials.



Bio-Organic Intermediates
Romania has traditions in simple bio-organic products but never built a strong biotech base.Output mainly serves domestic demand, while complex products are import-dominated. Global competitiveness is limited, yet local bio-resources offer some potential.

CASEIN
Derived from milk, casein is used in adhesives, food supplements, and pharma coatings. Given Romania's dairy sector, it may be processed locally and integrated into food-grade or industrial-grade formulations.

CELLULOSE N.E.C.
Cellulose derivatives are used in pharma, paper coatings. and biodegradable materials. In Romania, they are imported and processed by converters for packaging, hygiene products, or as binding agents in pharma.

ESSENTIAL OILS
Essential oils are extracted from Romanian-grown plants (lavender, pine, herbs) and exported as raw materials for cosmetics, aromatherapy, or food. Domestic use exists in artisanal and semi-industrial perfumery .

INDUSTRIAL MONOCARBOXYLIC FATTY ACIDS
These are bio-based intermediates from oils and fats. used in surfactants. lubricants. and cosmetics. Romanian firms may import and use them in blending, especially in bio-lubricant and personal care product formulation.

ISOCYANATES
These highly reactive compounds are used in polyurethanes and adhesives. Romanian automotive suppliers and construction material firms integrate them in foams. coatings, or laminated materials.

NUCLEIC ACIDS AND THEIR SALTS
While not extensively produced domestically, these inputs may be used in lab-scale or niche biotech applications (e.g., R&D hubs, pharma packaging).

ORGANO-SULFUR COMPOUNDS
Widely used in rubber vulcanization, pharma synthesis, and pesticides. Imported into Romania for downstream blending or transformation into specific compounds.

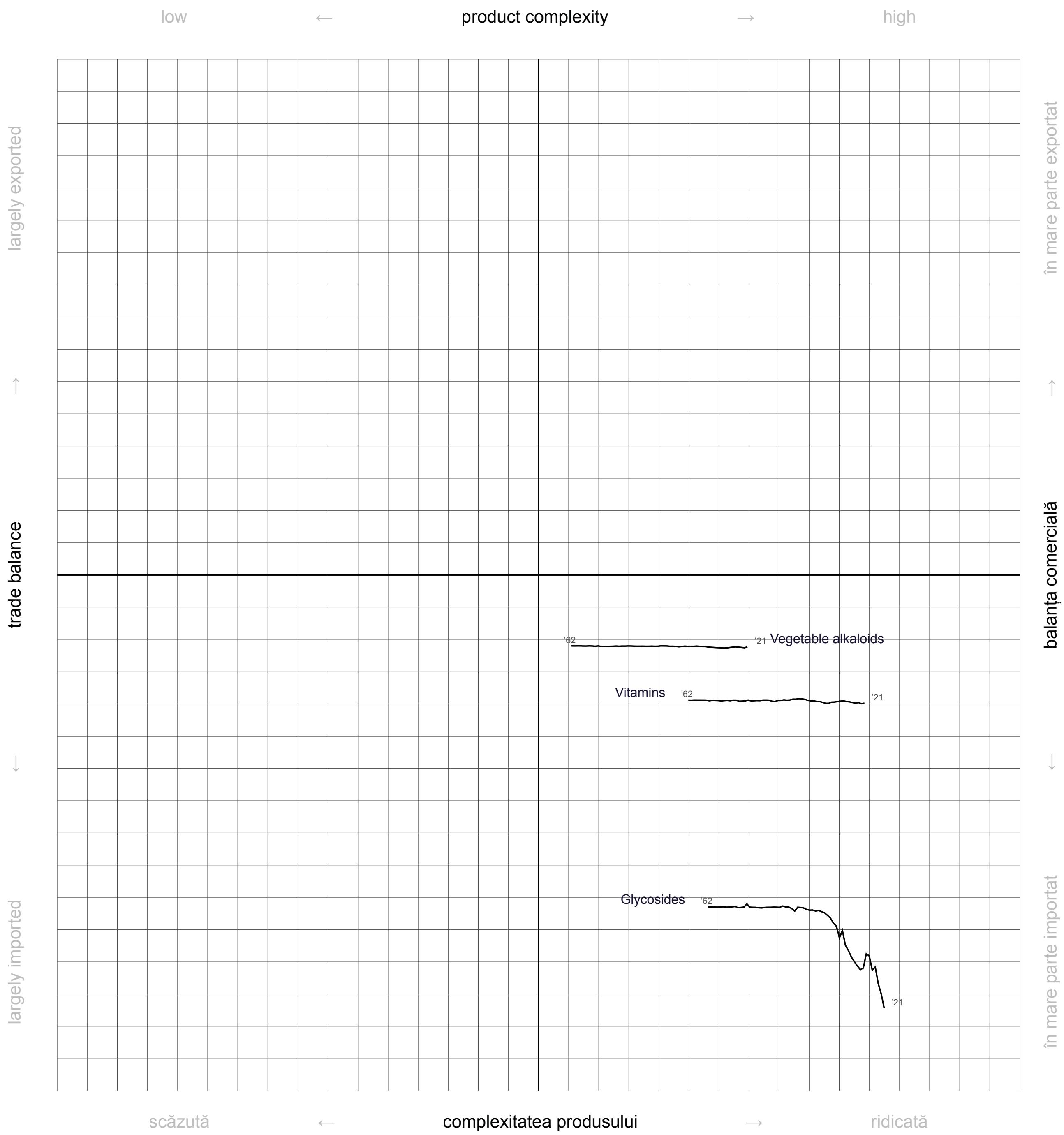
OTHER ORGANO-INORGANIC COMPOUNDS
This residual category includes several intermediates for electronics, catalysts, and advanced materials. Integration in Romania is limited to niche uses or transit trade.

OXYGEN-FUNCTION AMINO-COMPOUNDS
These compounds serve as chemical building blocks in agrochemicals, pharma, and biotech synthesis. In Romania, they are used in downstream formulations for pharmaceuticals or pesticide intermediates.

ROSIN AND RESIN ACIDS
These pine derived acids are used in adhesives, inks, and varnishes. Romania's forest sector enables some domestic sourcing, but chemical integration typically happens via SME coating and printing product manufacturers.

SULFONAMIDES
Mostly known for antimicrobial use, sulfonamides are integrated in pharmaceutical intermediate production. Romanian use occurs in toll manufacturing or as part of API formulation under license.

TALL OIL
A byproduct of wood pulping, tall oil is processed into resins, emulsifiers, and biofuels. In Romania, it is more imported and used by chemical intermediaries or coatings producers for niche blending

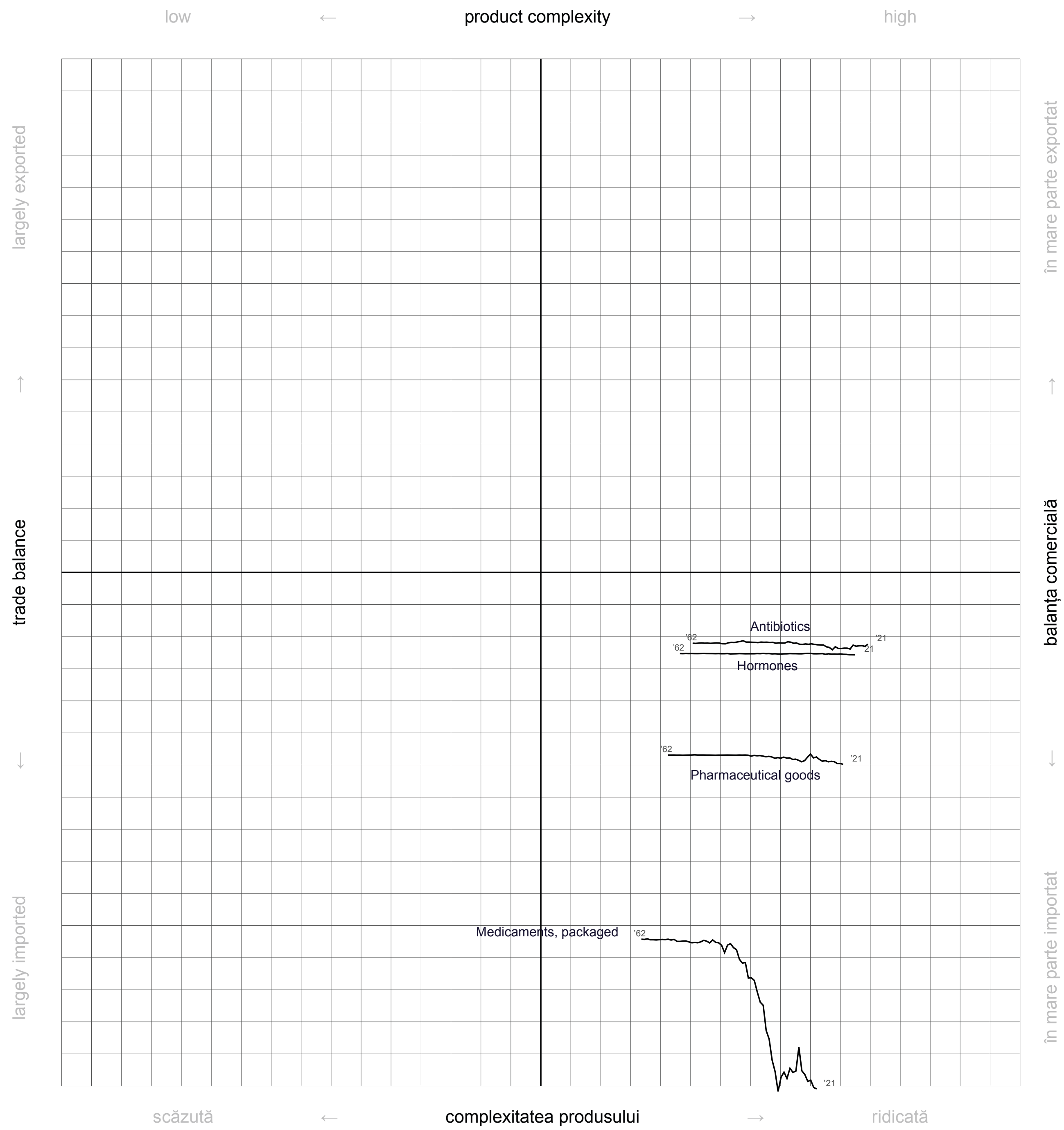


Bio-Pharma
Romania's bio-pharma industry is small and relies on imports for active ingredients. Local firms mostly package or formulate, but value added is low. The domestic market grows, yet external competitiveness remains weak.

GLYCOSIDES
Glycosides are plant-derived compounds with pharmacological properties (e.g., cardiac drugs, anti-inflammatories).
While domestic production is minimal, Romania may be involved in secondary transformation, extraction from herbal sources, or trade in intermediates for specialised pharma niches.

VEGETABLE ALKALOIDS
Vegetable alkaloids (e.g., morphine, quinine. atropine) are bioactive compounds used in both traditional and modern pharmaceuticals. Romania's integration is in downstream formulation or packaging, rather than extraction, though limited botanical sourcing may occur.

VITAMINS
Vitamins are used both as active pharmaceutical ingredients (APIs) and as nutritional additives. Romania imports and processes vitamins for packaging, encapsulation, and inclusion in dietary supplements and fortified food, often under contract with foreign pharma brands.



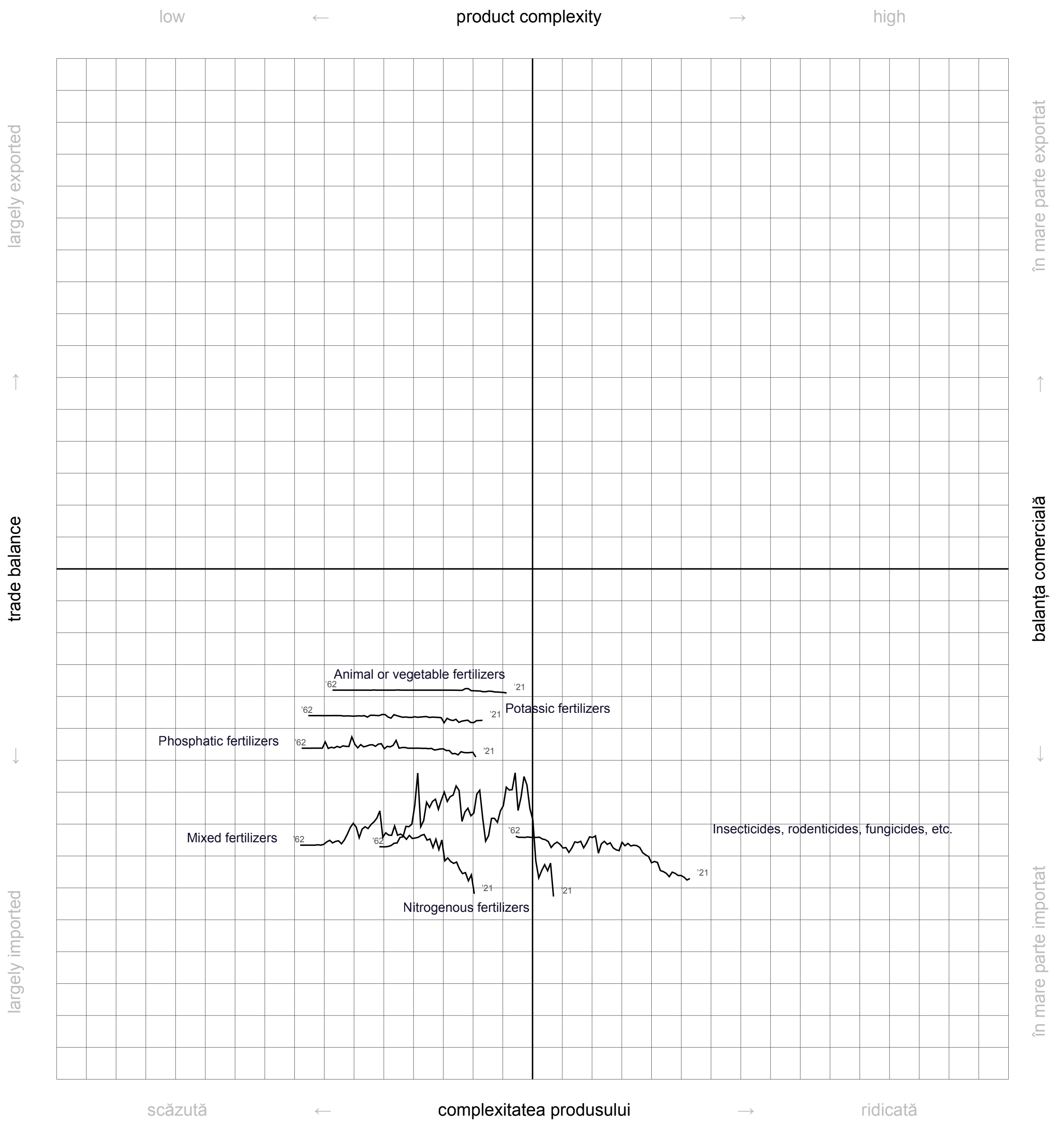
Pharmaceuticals
The pharmaceutical sector shifted from socialist factories to private firms producing generics. Exports exist,but imports of innovative drugs dominate. Romania stays dependent on global chains and external regulations.

ANTIBIOTICS
Romania imports a large share of its antibiotics in bulk form for tableting or packaging. Some firms act as contract manufacturers for Western companies; partial processing is done domestically.

HORMONES
Hormonal compounds are core active ingredients (APIs) in prescription drugs (e.g., steroids, contraceptives). Romania's pharma industry imports these for encapsulation, formulation, or repackaging, especially in Bucharest-Ilfov and Prahova.

MEDICAMENTS, PACKAGED
Final pharmaceutical products (blistered, boxed) are both imported and exported. Romania serves as a logistics and relabelling hub in EU generic distribution networks.

PHARMACEUTICAL GOODS
Includes diagnostic kits, surgical dressings, and specialised pharma items. Romania's hospitals and retail chains rely on imports, with low local production but growing warehousing and distribution capacity.



Agriculture and Fertilisers
Romania once produced large amounts of chemical fertilisers for farming. After 1990 many plants shut, imports rising sharply. Today only a few major sites operate, exposed to gas prices and market volatility.

ANIMAL OR VEGETABLE FERTILISERS
These products are used as inputs in primary agricultural production, particularly in crop farming. In Romania, they are to be consumed directly by domestic producers, especially in regions with intensive cereal and vegetable cultivation. Their integration is upstream in the agri-food value chain.

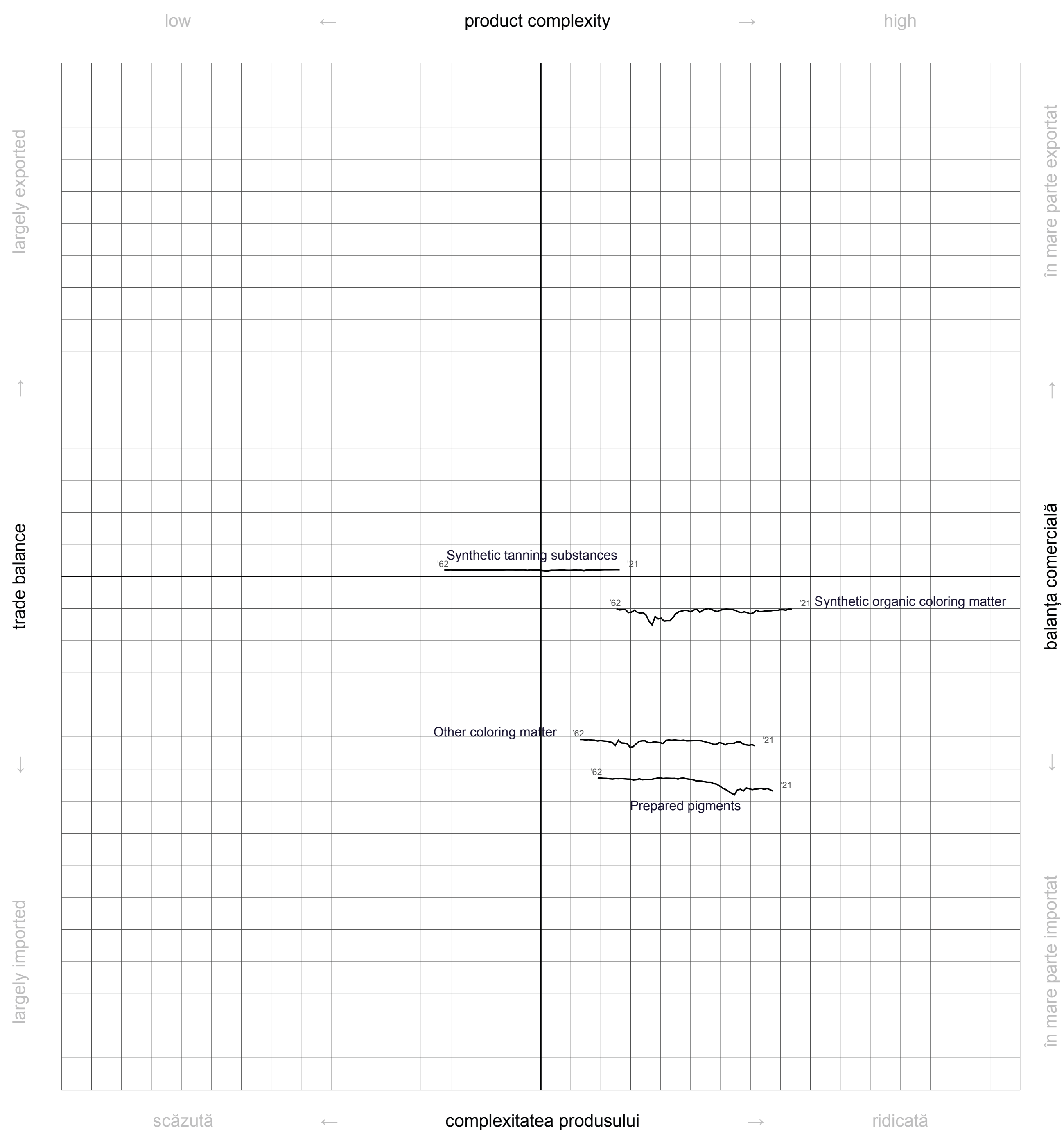
INSECTICIDES, RODENTICIDES, FUNGICIDES, ETC.
These agrochemical products support intensive farming through pest and disease control. In Romania, they are key components of integrated crop management systems. Integration is downstream in agriculture, typically via distributors to farms. Some formulation may occur domestically, but active ingredients are largely imported.

MIXED FERTILISERS
These are blended products tailored to specific crops or soil types. Romanian agri-businesses use them to optimize yields, especially in high-input farming regions. Integration occurs both through direct imports and via local formulation from imported components.

NITROGENOUS FERTILISERS
Nitrogen-based fertilisers are a cornerstone of industrial agriculture. They are heavily used by Romania's grain producers and large agro-industrial platforms. Domestic production exists but relies on imported inputs: Imports fill demand gaps or complement production for specific formulations.

PHOSPHATIC FERTILISERS
Phosphatic fertilisers are critical in soil enrichment and are widely applied in Romanian crop systems. Integration is primarily in upstream agricultural supply chains. Romania lacks significant domestic phosphate extraction, making imports structurally necessary.

POTASSIC FERTILISERS
Potassium-based fertilisers improve plant resistance and yield. Romania does not extract potash domestically. So these are fully importreliant. They enter through agri-input distributors and are used across major crop regions.



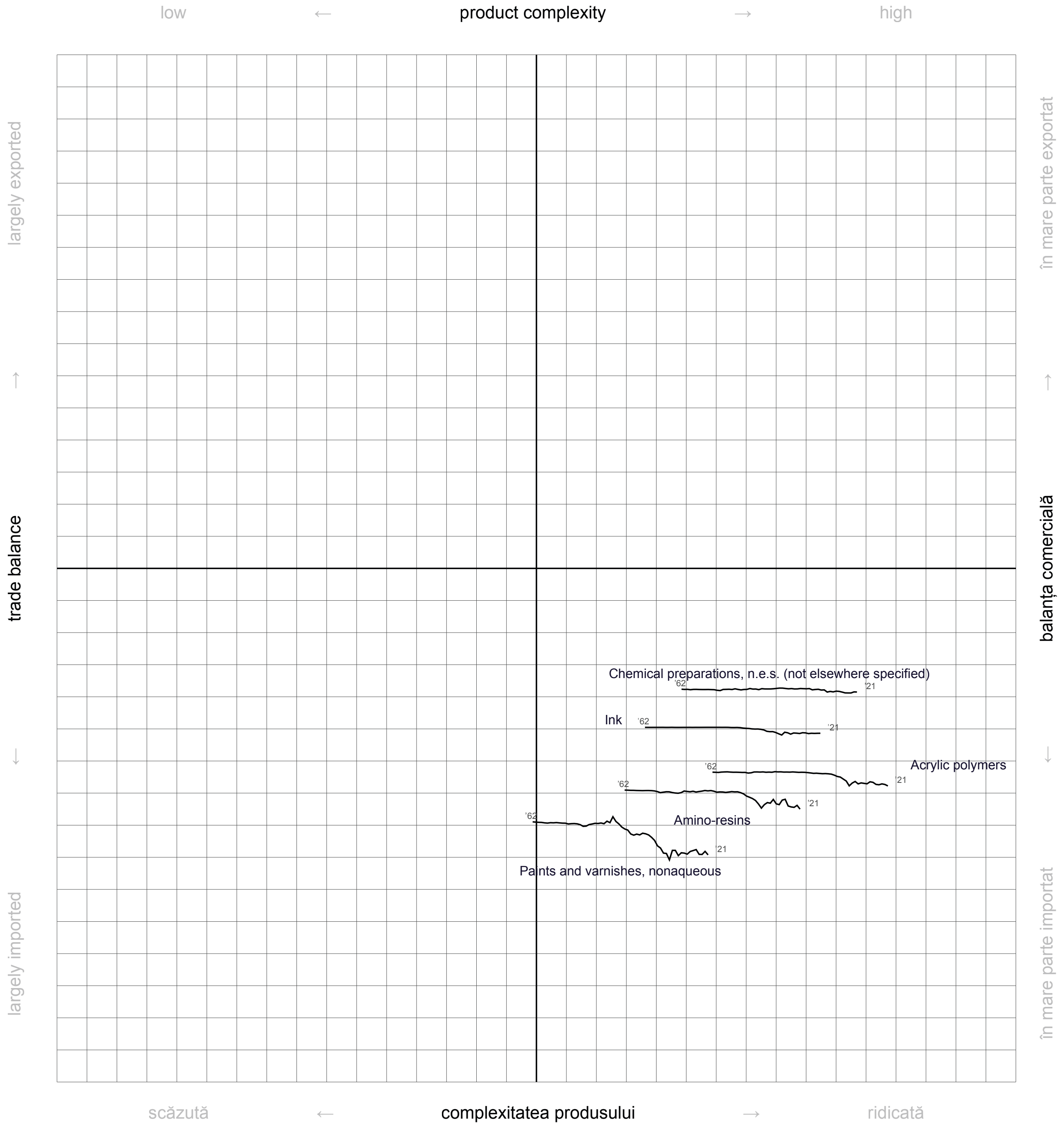
Dyes and Pigments
The dyes and pigments industry was once significant, but after 1990 it shrank drastically. Imports dominate, local output is minor. A few niches in special pigments survive, but Romania's role in global trade is limited.

OTHER COLOURING MATTER
Includes inorganic pigments used in construction (cement coloration), paints, and low-cost textiles.

PREPARED PIGMENTS
These are value-added colourant compounds used in coatings and plastics—imported for use in packaging and surface treatments.

SYNTHETIC ORGANIC COLOURING MATTER
Widely used in plastics, textiles, inks, and cosmetics. Romania is a downstream consumer with marginal local production.

SYNTHETIC TANNING SUBSTANCES
Used in the leather and textile industry. Romania has residual tanning capacity (e.g., Maramureş) and imports these agents for processing hides.



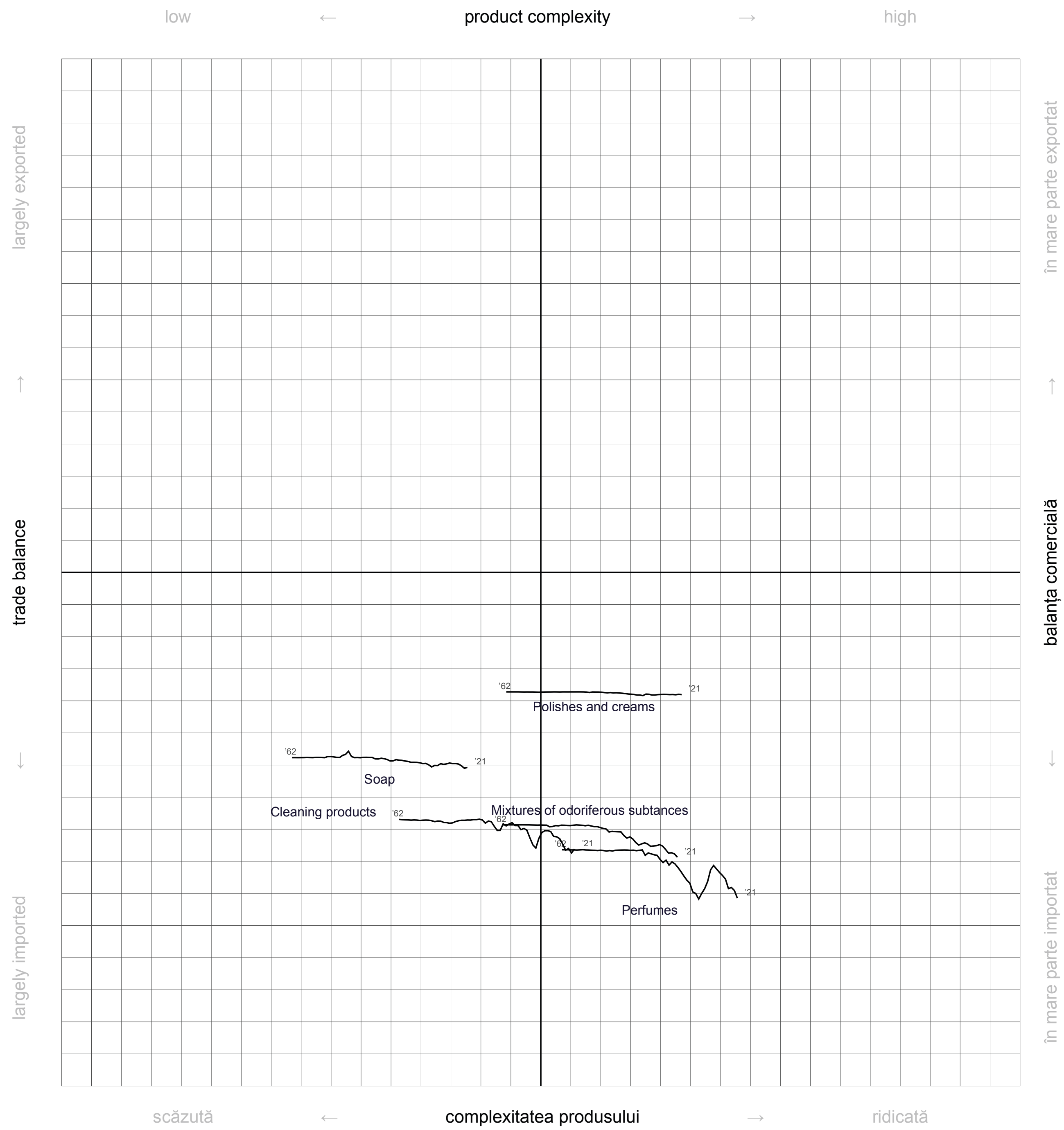
Coatings and Adhesives
Coatings and adhesives remain active, with private firms and foreign investment. Exports expand, especially for construction and automotive. Romania blends industrial traditions with modern adaptation, keeping a regional competitive profile.

ACRYLIC POLYMERS
These are key in paints, adhesives, and surface coatings. In Romania, they serve as polymer bases for construction chemicals and waterproofing materials.

AMINO-RESINS
Used extensively as binders in wood adhesives and coating formulations. Romanian applications include furniture manufacturing and industrial wood panel production.

INK
Inks are used in printing, packaging, and labeling. Romanian facilities, especially in the packaging and publishing sectors, import both base formulations and finished products.

PAINTS AND VARNISHES, NONAQUEOUS
Romania has several mid-size paint and coatings manufacturers: this category includes both local production and imported inputs for construction, furniture, and automotive use.



Cosmetics and Personal Care
Cosmetics grew after 2000, driven by global brands and domestic demand. Local production exists, yet premium imports dominate. With young dynamic consumers, Romania's exports remain modest.

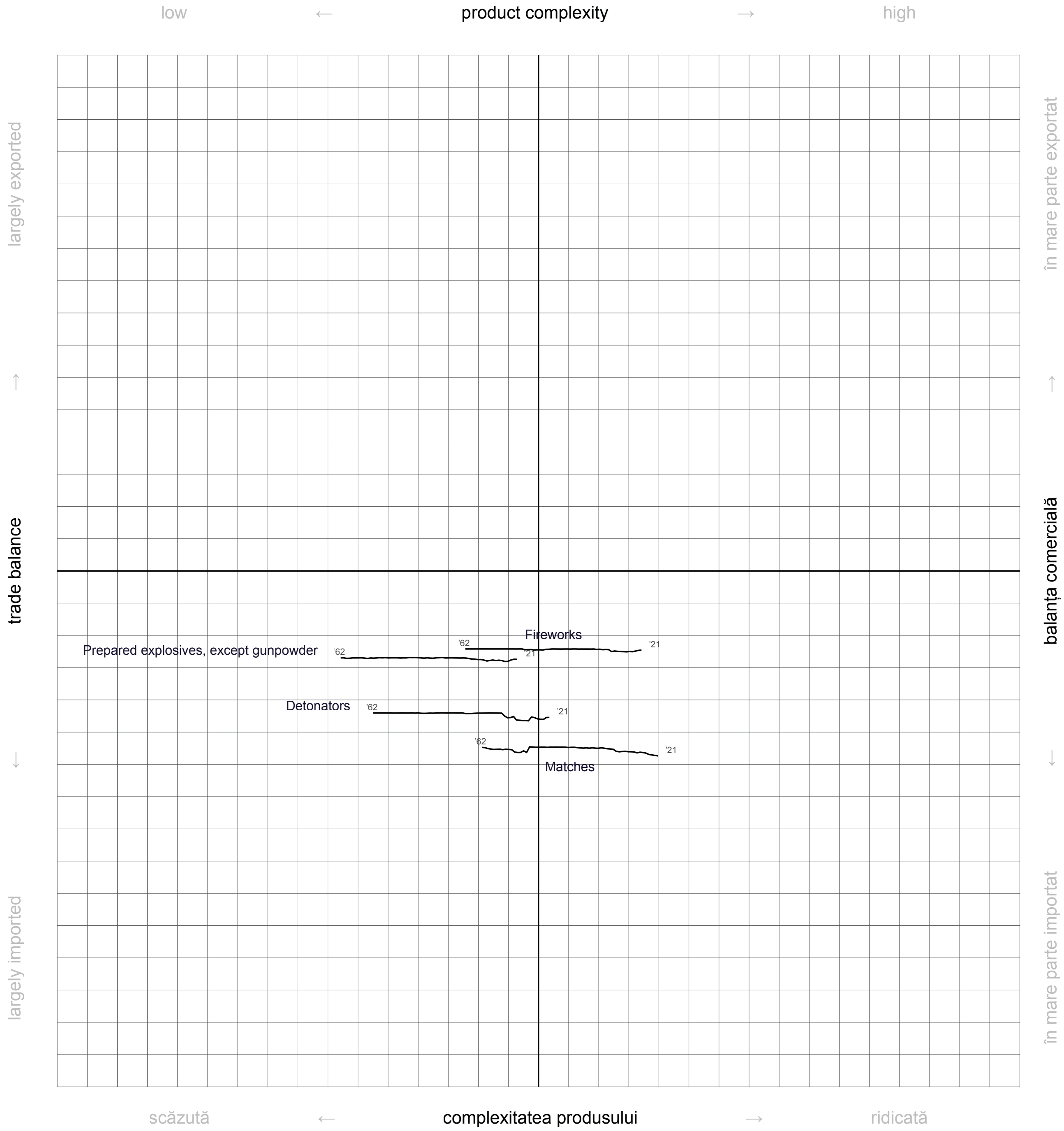
CLEANING PRODUCTS
Common in household chemical production, with Romania hosting local facilities of multinationals (e.g., Procter & Gamble).

MIXTURES OF ODORIFEROUS SUBSTANCES
These are fragrance precursors for perfumes, soaps, and personal care products. Romania imports them for local packaging and formulation.

PERFUMES
Romania participates mainly at the packaging and distribution end of the supply chain, with local brands using imported fragrance bases.

POLISHES AND CREAMS
These are niche but relevant inputs for domestic manufacturing of shoe care, floor wax, and industrial maintenance products.

SOAP
Romania has legacy production of basic soap products; both domestic and foreign firms source intermediates and re-export branded products.



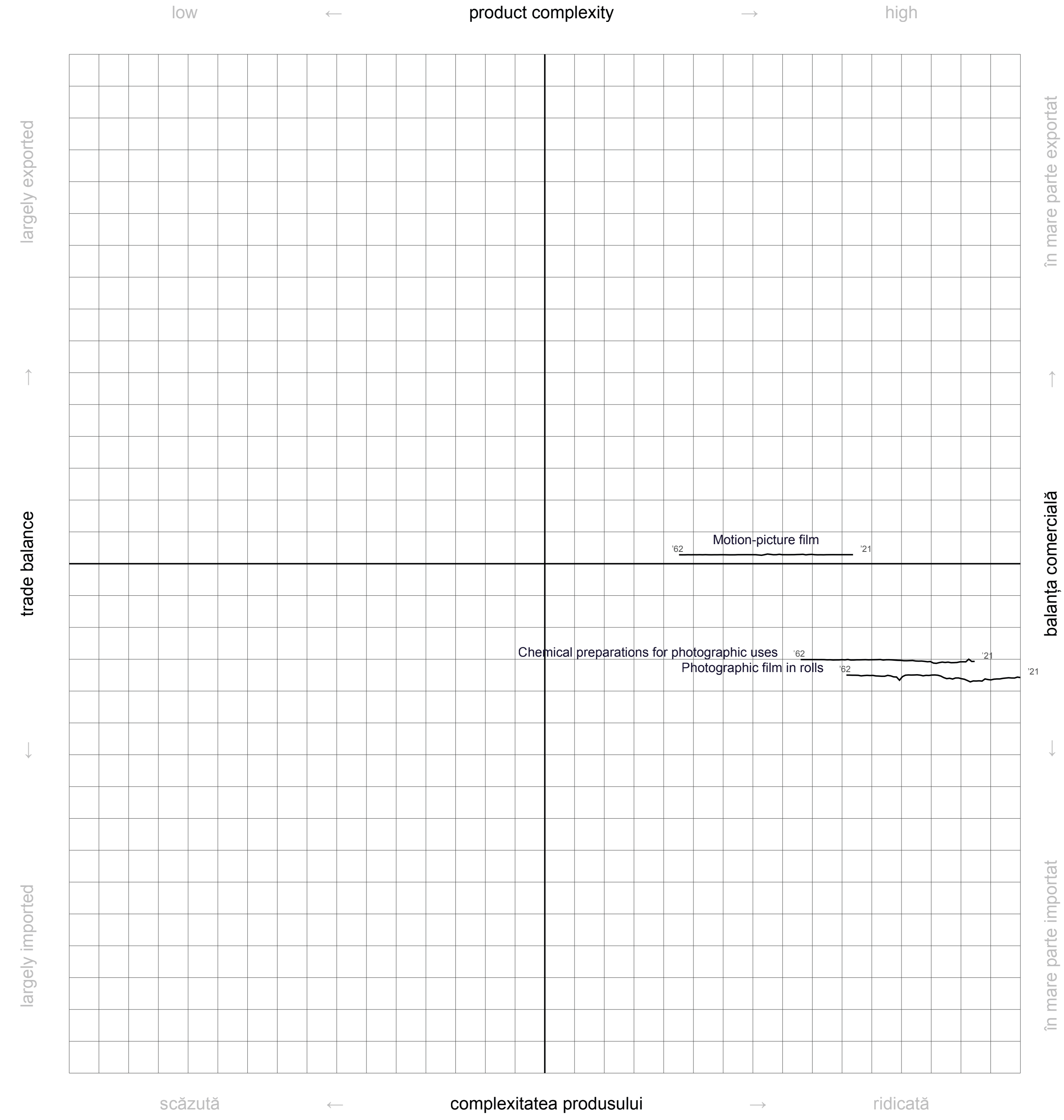
Explosives and Pyrotechnics
Romania produced explosives for mining and industry.
After 1990 demand fell, many plants closed. Pyrotechnics remain marginal, mostly for entertainment. The sector has more of a historic than a commercial role.

DETONATORS
Safety and mining detonators are imported by Romanian construction and extractive industries.

FIREWORKS
Imported for seasonal use: Low domestic production. Limited to regulated entertainment and military suppliers.

MATCHES
Romania had historic production, now largely replaced by imports. This is a marginal consumer good category.

PREPARED EXPLOSIVES
(EXCEPT GUNPOWDER)
Used in mining, construction, and defense. Romania's role is limited but includes state-regulated importation for resource extraction.

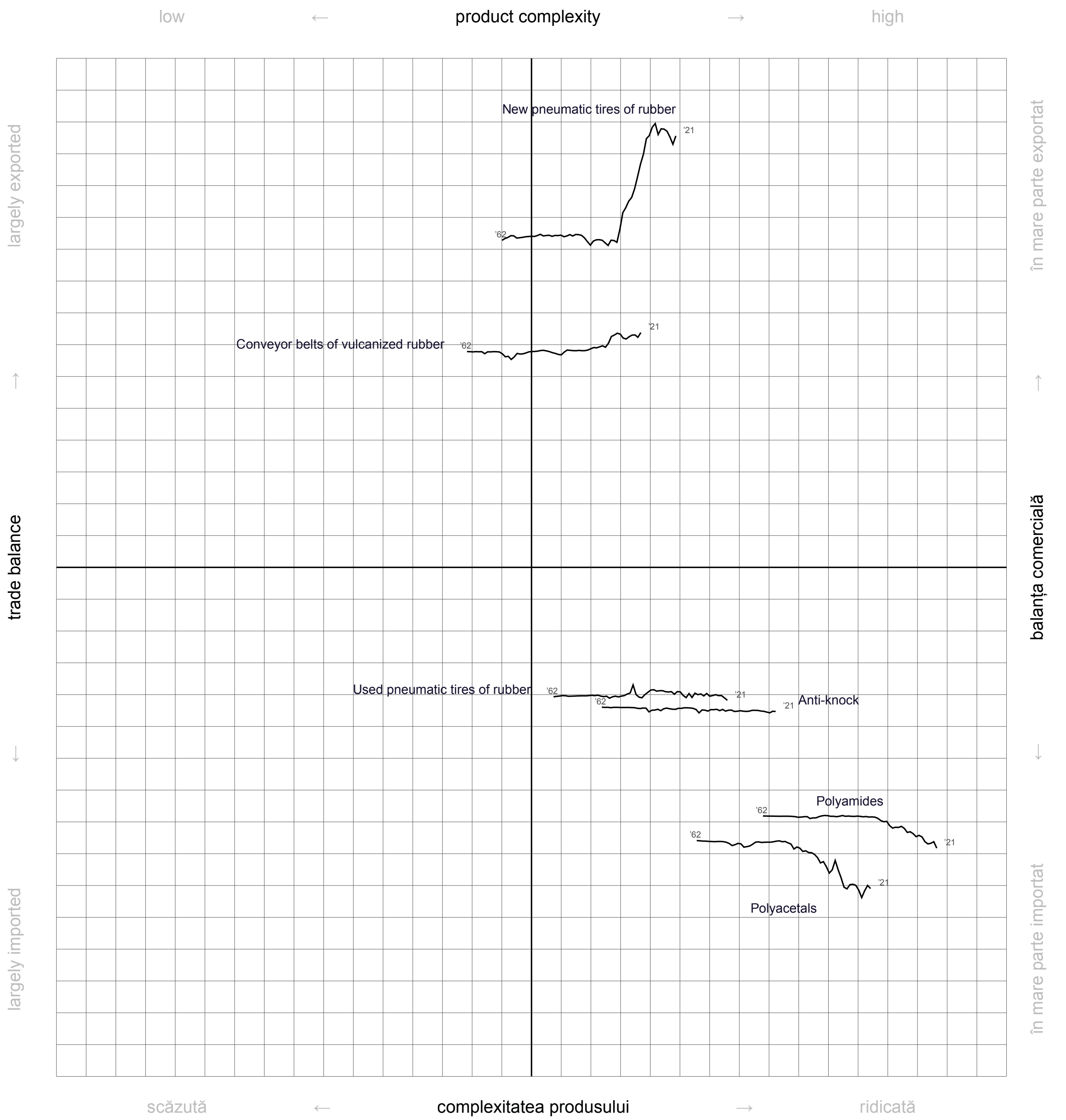


Media Products
Chemicals for film, photography, or printing were central before digitalization. Today they almost vanished, with imports covering rare needs. It's a case of rapid technological obsolescence.

CHEMICAL PREPARATIONS FOR PHOTOGRAPHIC USES
Legacy use in film photography and specialised printing. Still imported for niche industrial or artistic purposes.

MOTION-PICTURE FILM
Used in cinema preservation or analog-format production: low but non-zero relevance in Romania.

PHOTOGRAPHIC FILM IN ROLLS
Demand has diminished, but some niche imports continue for analog photography and archival use.



Automotive
Automotive chemicals – fluids, special rubbers, paints – became export pillars. The auto industry pulled suppliers into European chains. A competitive, export-oriented branch.

ANTI-KNOCK
Anti-knock agents (e.g. MTBE) are fuel additives used to improve engine performance. In Romania, their integration is indirect, through blending and distribution by fuel companies. Their classification within automotive reflects their functional end-use, although they do not enter car manu-facturing plants directly.

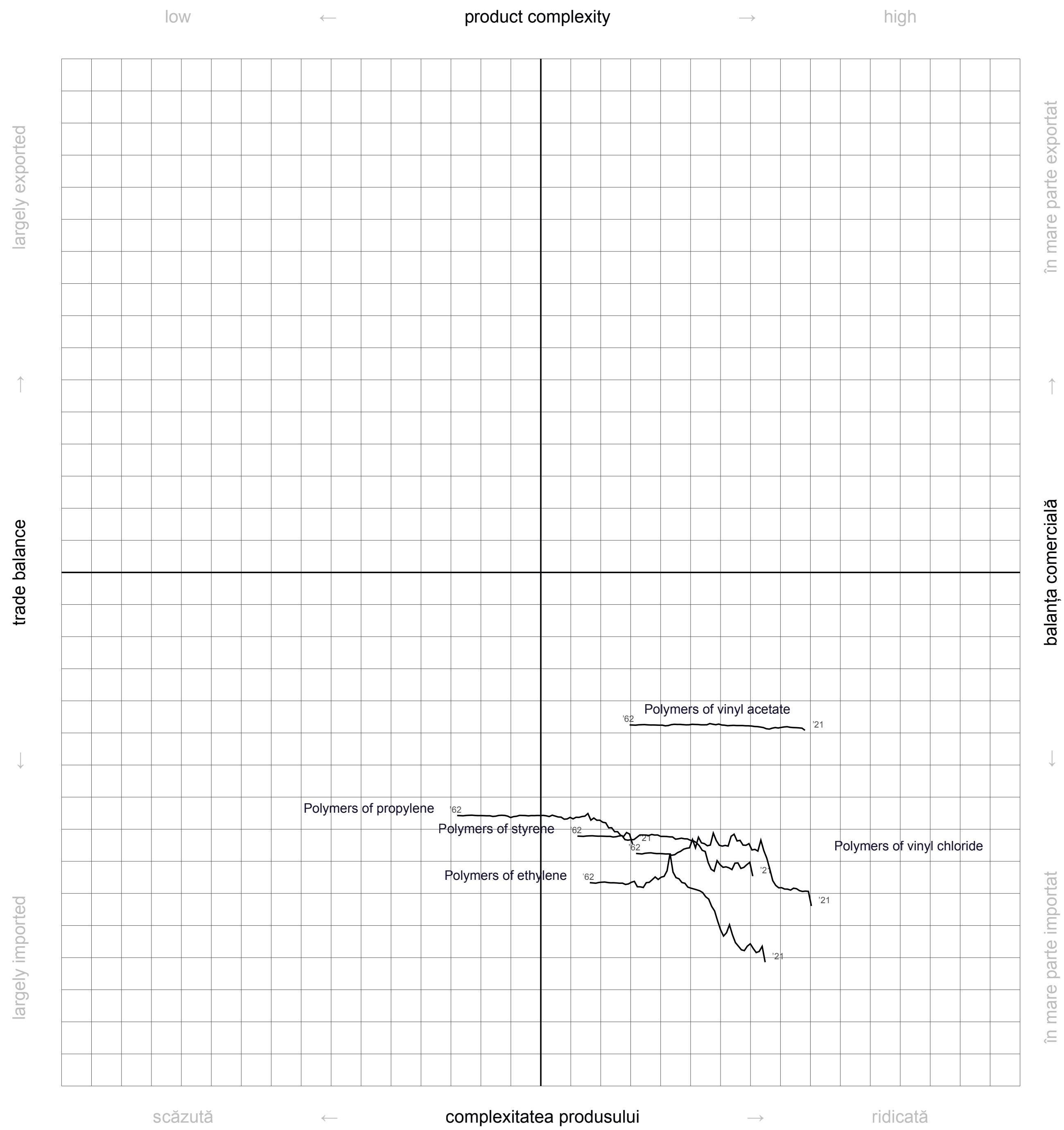
CONVEYOR BELTS OF VULCANISED RUBBER
These belts are used in production and intralogistics systems, including final assembly lines and material handling in car plants. In Romania, demand comes both from OEMs (e.g., Ford Craiova, Dacia Mioveni) and from Tier 1 suppliers operating large-scale facilities. Integration is industrial, not vehicular, but still within the automotive ecosystem.

NEW PNEUMATIC TIRES OF RUBBER
Romania has significant tire manufacturing capacity (e.g. Continental in Timișoara), but also imports high volumes for both OEM and aftermarket sales. These products are integral to the automotive supply chain and aftermarket services. Imports complement domestic production or serve specific brands/models not made locally.

POLYACETALS
Polyacetals (POM) are high-performance engineering plastics used in precision automotive components such as fuel systems, gears, and housings. In Romania, they are primarily imported as raw material and processed in Tier 2 or Tier 3 suppliers operating in automotive plastics molding, often within industrial parks in regions like Argeș, Brașov or Timiș.

POLYAMIDES
Polyamides (e.g., PA6, PA66) are widely used in the automotive sector for under-the-hood components, structural parts, and connectors due to their mechanical strength and heat resistance. Romania hosts a range of foreign-owned plastics processors supplying OEMs, so these poly-mers are integrated into localized manufacturing chains in Cluj, Sibiu, and Arad.

USED PNEUMATIC TIRES OF RUBBER
Used tires are part of the automotive aftermarket and re-cycling chain.
In Romania, they are imported for retreading. resale, or disposal, often by specialised waste management and refurbishment frms. Though not part of OEM manufacturing, they relate to vehicle life-cycle services.



Commodity Thermoplastics
Romania once produced polyethylene, polypropylene, and other plastics.
After 2000 production shrank, imports took over. Only a few units remain, making the sector vulnerable and import-dependent.

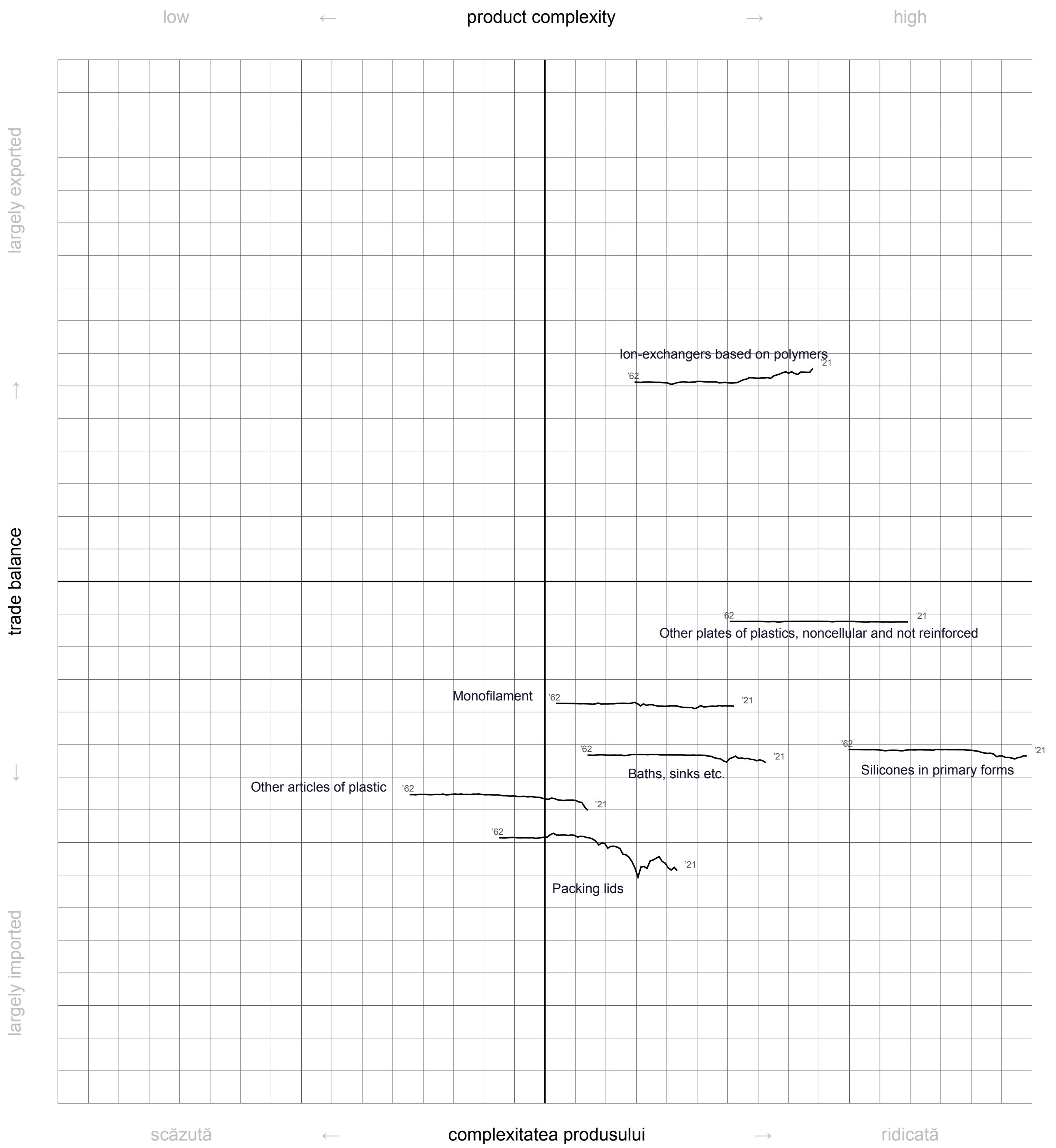
POLYMERS OF ETHYLENE
Ethylene polymers (e.g., polyethylene) are among the most widely used plastics globally. In Romania, they are integrated in packaging (films, containers), construction (pipes), and cable insulation. These are processed both by large converters and SME manufacturers in industrial parks.

POLYMERS OF PROPYLENE
Polypropylene is used extensively in automotive parts, textiles (nonwovens), packaging, and appliances. In Roma-nia, it enters through major compounders and converters linked to the automotive and FMCG sectors (e.g., Jucu, Arad). It is part of both domestic consumption and re-export through processed goods.

POLYMERS OF STYRENE
Styrene polymers (including polystyrene) are used in insulation, consumer goods, and packaging. In Romania, they are transformed into foams, containers, and disposables, especially in southern and western industrial zones.

POLYMERS OF VINYL ACETATE
These polymers are often used in adhesives, coatings, and flexible films. In Romania, they are integrated in construction adhesives and flexible packaging applications.
Their use is more specialised compared to polyethylene or polypropylene but still part of core thermoplastic trans-formation sectors.

POLYMERS OF VINYL CHLORIDE
Polyvinyl chloride (PVC) is a key plastic in construction, pipes, window profiles, flooring. Romania has a robust construction materials industry that uses PVC both in greenfield production and in retrofit markets. Imports serve as feedstock for extrusion and molding operations



Plastics and Packaging Materials
Plastic packaging turned into an export pillar, tied to European demand. Romania exports strongly, even if raw materials are imported. A dynamic but environmentally controversial branch.

BATHS, SINKS ETC.
Finished plastic goods used in construction and home improvement, often re-exported or distributed via retail chains: Imported semi-finished and finalised in Romania.

ION-EXCHANGERS BASED ON POLYMERS
Used in water purification, pharmaceuticals, and catalysis.
Used in industrial installations (e.g., energy, pharma), with niche domestic transformation.

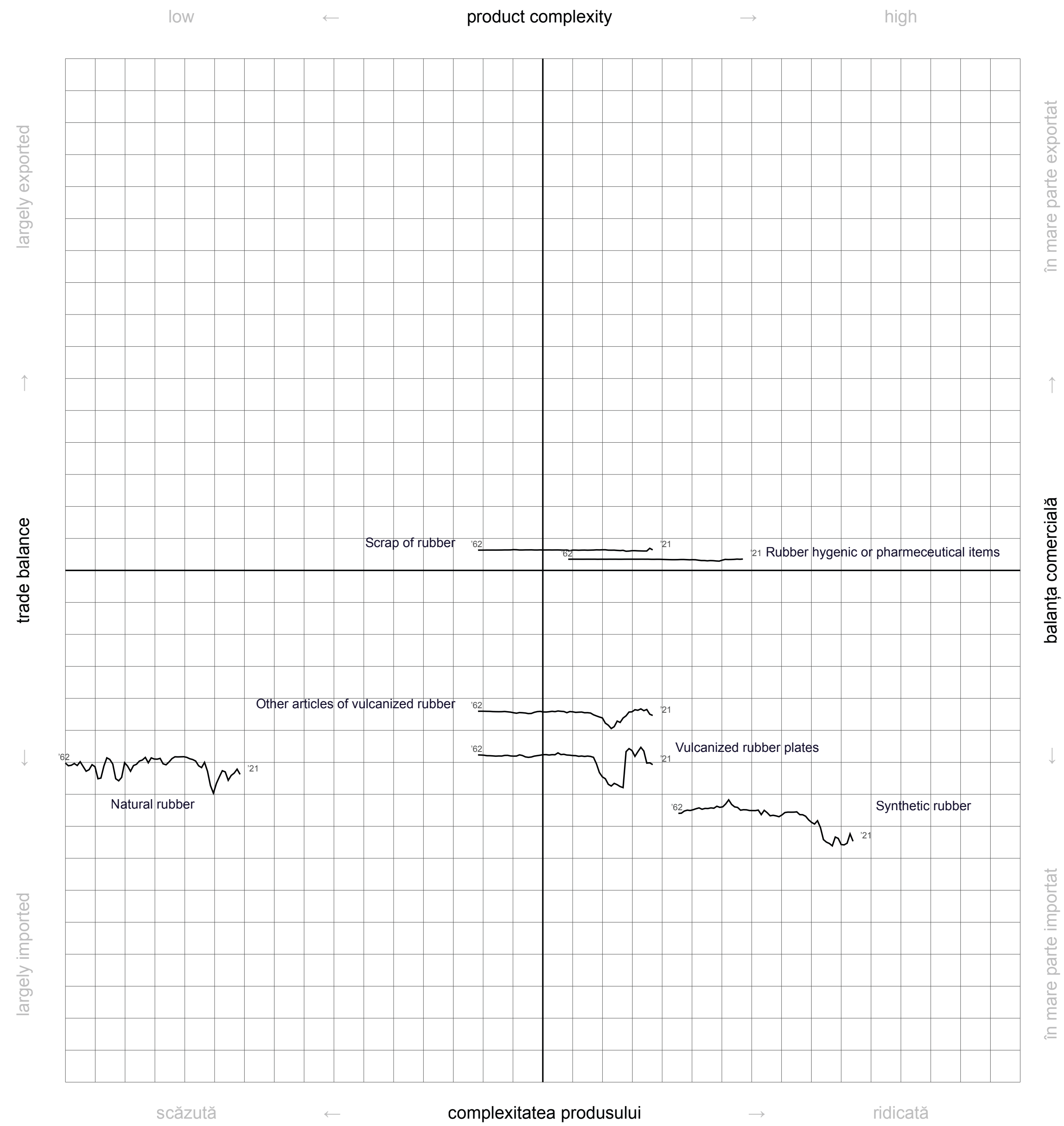
MONOFILAMENT
Monofilament is processed into filters, brushes, and agricultural twine. Romania's usage is linked to light manufacturing and agri-industrial needs.

OTHER ARTICLES OF PLASTIC
A residual category for consumer goods, tools, and hard-ware. Romania imports many items but also hosts light industry in this domain.

OTHER PLATES OF PLASTICS, NONCELLULAR AND NOT REINFORCED
Input for thermoforming, signage, and construction panels.Romania has domestic processors and converters in urban and peri-urban areas (e.g., Ilfov, Arad).

PACKING LIDS
Used in food and pharmaceutical packaging. Integrated by Romanian converters serving FMCG and export logistics.

SILICONES IN PRIMARY FORMS
Used in sealants, construction, automotive, and electronics. Romania integrates silicones via converters (e.g., adhesives, tubes) mostly for export markets.



Rubber Industry
Synthetic rubber and rubber goods supported automotive industry and exports. After 2000, output stabilised, tied to European chains. Romania kept a competitive edge, specialising in tires and technical goods.

NATURAL RUBBER
Romania imports natural rubber for tyre, gasket, and belt manufacturing. Mostly transformed in automotive-linked facilities (e.g., Continental, Pirelli).

OTHER ARTICLES OF VULCANISED RUBBER
A wide category used in automotive, machinery, and sealing systems. Strong Romanian integration, especially via automotive subcontracting.

RUBBER HYGIENIC OR PHARMACEUTICAL ITEMS
Includes gloves, tubes, and sanitary items. Most are imported for hospital and industrial use: some local packaging or sterilisation may occur.

SCRAP OF RUBBER
Recycled rubber enters circular processes or downcycled into playground surfaces or insulation. Romania has limited but growing recycling capacity.

SYNTHETIC RUBBER
Used extensively in automotive, seals, and hoses. Romanian usage is focused in Arad, Timișoara, and Slatina clusters.

VULCANISED RUBBER PLATES
Inputs for gaskets, shock absorbers, and conveyor systems. Romania processes these for automotive and light industry.

Mirroring the Ecosystem

2.1

Mirroring the Ecosystem

Field Research

Valentina Ciobanu
Martina Muzi
Oana Simionescu

Photo&Video

Alex Todirică

Mirroring the Ecosystem is an ongoing research project that maps the material and social contours of industry. Focusing on Romania's chemical sector, through visiting sites, collecting archives, and engaging in conversations, the team has traced the links between production, landscape, and daily life. Gathering the expertise of engineers and workers encountered in mines, quarries, and factories, the resulting project offers an accessible way for people from a variety of disciplines to understand what can be discovered through industrial knowledge.

The resulting collection includes interviews, a photographic essay, and material samples—powders, liquids, and products—that serve as tangible evidence of the vast number of material states that are involved in this industry. In the exhibition, wall images are arranged by location and process, revealing hidden interdependencies.

A central table, constructed from standard factory furniture and repurposed tile offcuts from Cesarom, embodies this approach. These tiles, leftovers from an interrupted production line, are given a new purpose. Together, these elements illuminate often-obscured dynamics: the distribution of risk, the maintenance of infrastructure, and the forms of tacit knowledge that persist within industrial ecosystems.

Brenntag SRL
Brenntag Romania is the local subsidiary of Brenntag SE, founded in 1874 in Berlin, recognised as a global leader in chemical and ingredient distribution. It offers business-to-business distribution solutions for industrial and specialty chemicals worldwide, bridging chemical producers and end users.


ROSD3220112
ROMO3120610
ROBD1210105
ROSD3230305
ROSD3230304
ROMG3220209
ROMG3230605
ROSD3220109
ROBG1200320

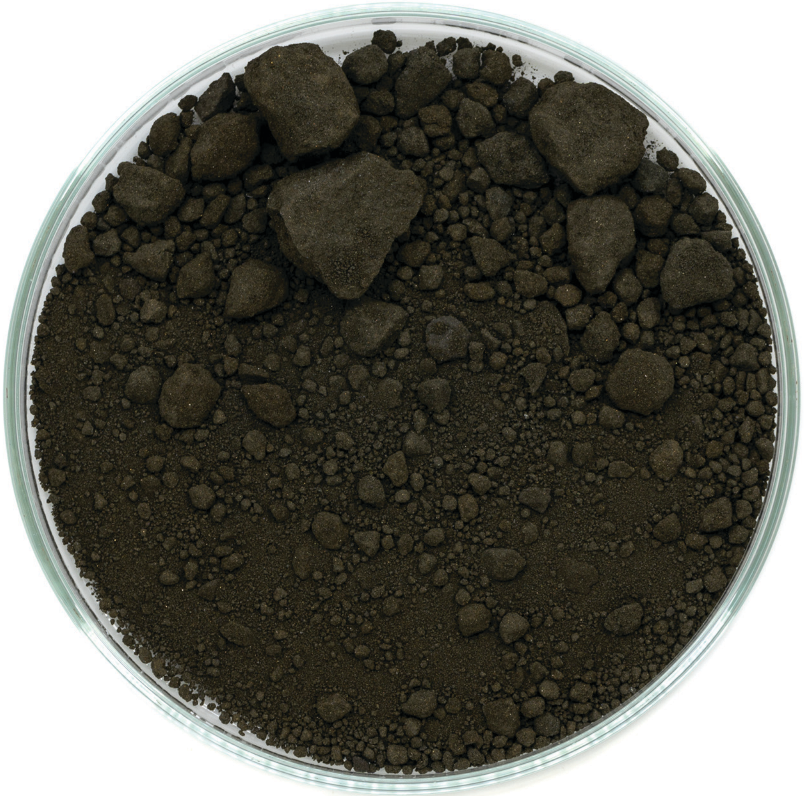
CupruMin SA

CupruMin SA is a Romanian state-owned mining company based in Abrud, Alba County. It specialises in the extraction and processing of copper ore from the Roșia Poieni deposit — the largest copper reserve in Romania. The company plays a key role in the country's non-ferrous metals sector, focusing on sustainable resource management and technological modernisation.

Rock sample from the Roșia Poeni copper mine, representing the raw material from which copper concentrate is extracted; in nature, copper occurs only as small particles.

The milling process of the stone is carried out to prepare a finely ground ore slurry, which will then go to flotation to separate the ore from the tailings.

The foam that is formed contains copper and represents the moment when the ore separates from the tailings.



Copper concentrate containing 20% copper, as well as silver and gold particles, serves as the raw material for extracting 99.99% pure copper.

A flower-shaped mineral formation representing the natural crystallisation of pyrite, that has a higher concentration of copper.


2600

Băița Bihor SA
A Romanian extractive industrial company, founded in 2004, and headquartered in Băița-Plai, Bihor County, specialising in the extraction, processing, and sale of limestone and dolomite.

Dolomite 64 nm

Dolomite 0-0,5 mm

Limestone 1-1,5 mm

Dolomite 0-3 mm

Limestone 200 nm

Limestone 0-0.008 mm

Limestone 1-1,5 mm

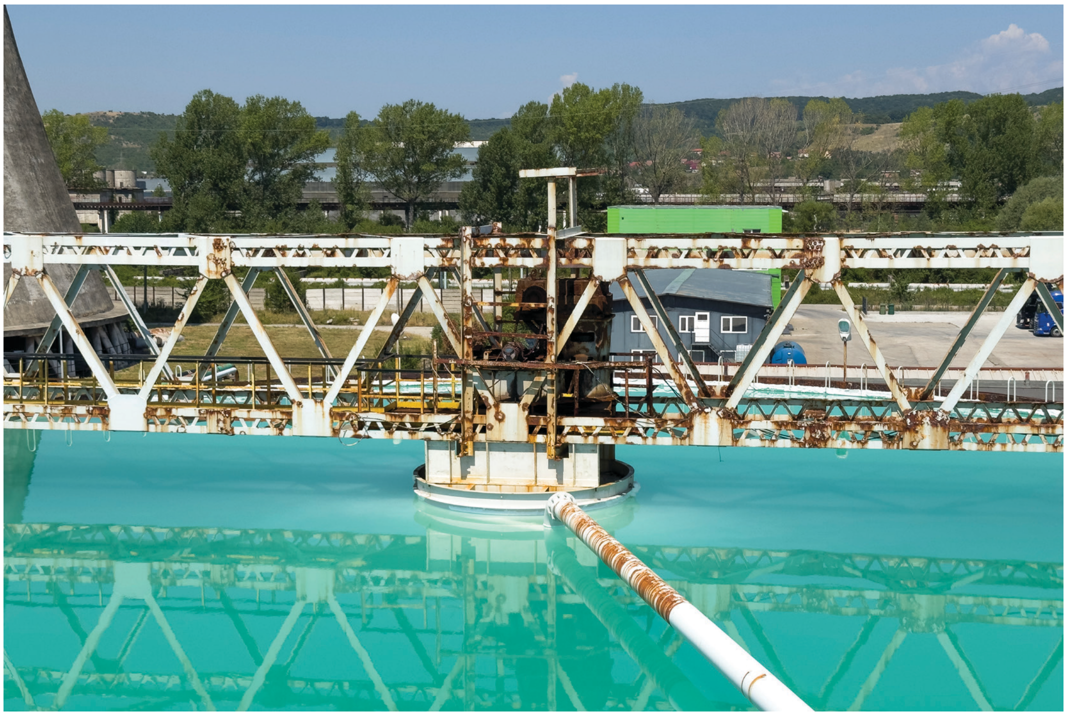
Limestone 1-1,5 mm

Processed crystals of table salt.

Unprocessed rock salt.

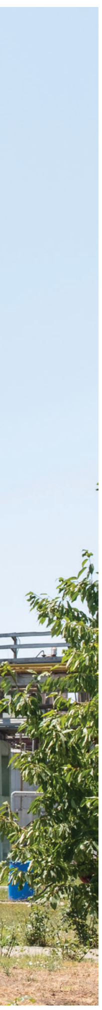
Salrom SA
A Romanian majority state-owned company, it is the country's main salt producer and one of the most important exploiters of non-metallic mineral resources. The company currently operates salt mines in Slănic Prahova, Ocna Mureș, Praid, Ocna Dej, Râmnicu Vâlcea, Târgu Ocna, and Cacica.

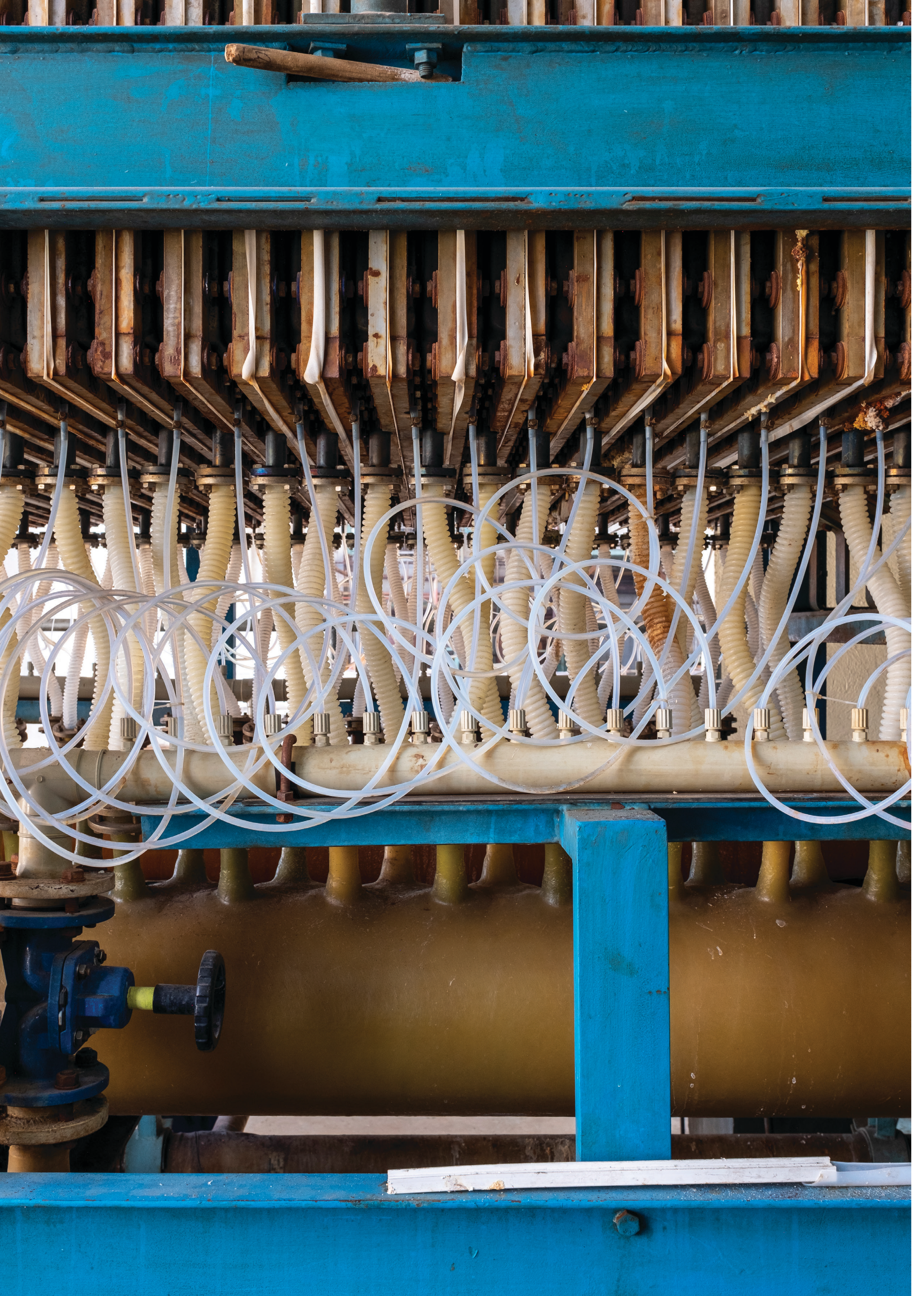
The first level of the Ocnele Mari Salt Mine (near Râmnicu Vâlcea) has been transformed into a leisure area offering various activities for visitors coming for speleotherapy; salt extraction continues on level 2 of the mine, 16 meters below the first level.



Chimcomplex SA (Oltchim)
The largest chemical producer in Romania, specialising in polyols, chlor-alkali products, and oxo-alcohols, with its main industrial platforms in Borzești-Onești (Chimcomplex) and Râmnicu Vâlcea (Oltchim).

Through the process of electrolysis of salt brine, chlorine, hydrogen, and sodium hydroxide (caustic soda) are produced.

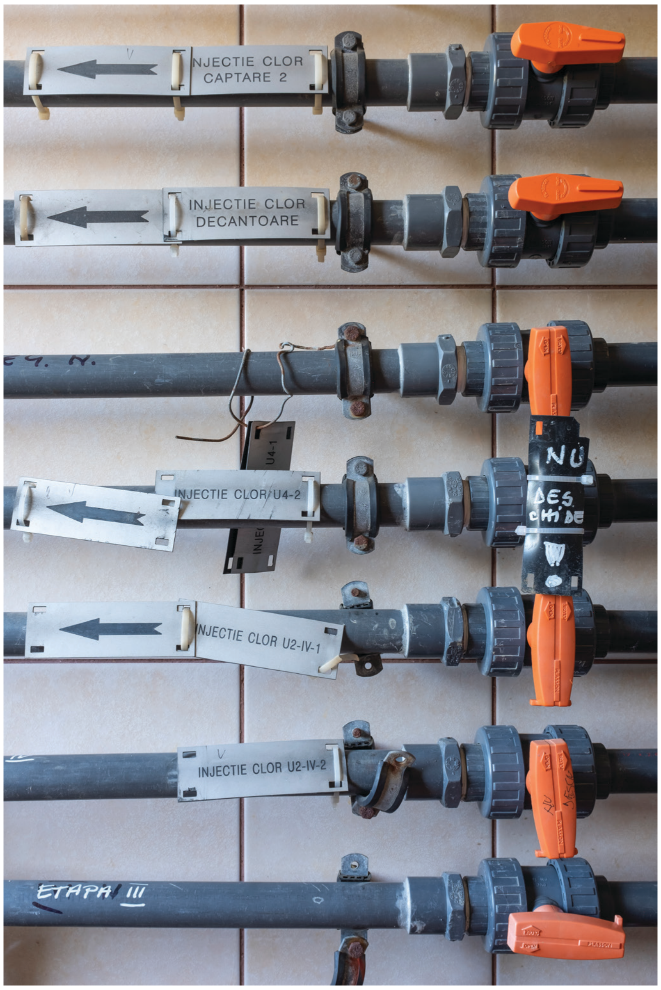


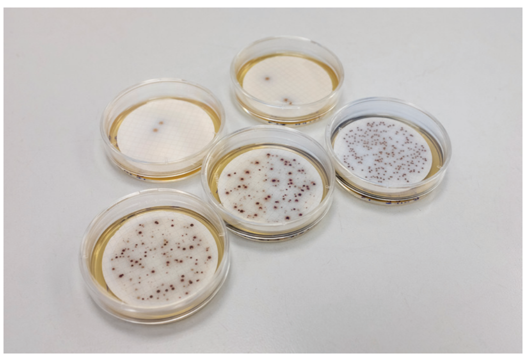


Caustic soda flakes

NAME Caustic Soda Solution
PRODUCT APPLICATIONS Petroleum industry, petrochemical industry, soap and detergent manufacturing, pulp industry, chemical treatment of wood, chemical industry in the production of dyes, phenol, phosphates, sodium hypochlorite, aluminum industry
PROPERTIES Strongly alkaline solution
COMPOSITION NaOH min. 48%
ROLE OF COMPONENTS Strong alkaline degreasing agent
RESULTING WASTE Brine filter cake
DESTINATION OF WASTE Stored in a non-hazardous waste landfill
INDUSTRY Petroleum industry, petrochemical industry, soap and detergent manufacturing, pulp industry, chemical treatment of wood, chemical industry in the production of dyes, phenol, phosphates, sodium hypochlorite, aluminum industry
ORIGIN Serbia, Bulgaria, Czech Republic, Slovakia, Poland, Hungary, Turkey, Slovenia
QUANTITY PROD./YEAR 120,000 tons/year for the Râmnicu Vâlcea platform
PRODUCTION RATE Continuous flow installation produces 14 tons/hour
WORKERS/PROD. LINE 30
Production process automatically controlled through a DCS (Distributed Control System)
ENERGY RESOURCE Mix of purchased electricity and electricity produced in cogeneration facilities
ENERGY COST/TOTAL PROD. 63%

Aquatim SA
The regional operator of water supply and wastewater services in Timiș County, providing drinking water to around 570,000 residents and sewage services to 74% of the population. Established in 1992, the company constantly invests in infrastructure modernization and environmental protection, being involved in projects such as the Water Museum in Timișoara, inaugurated in 2023.

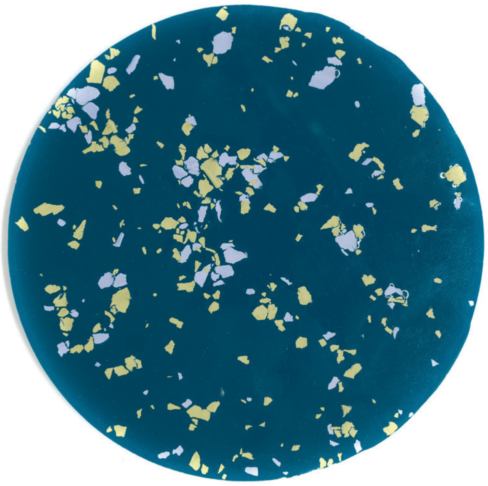


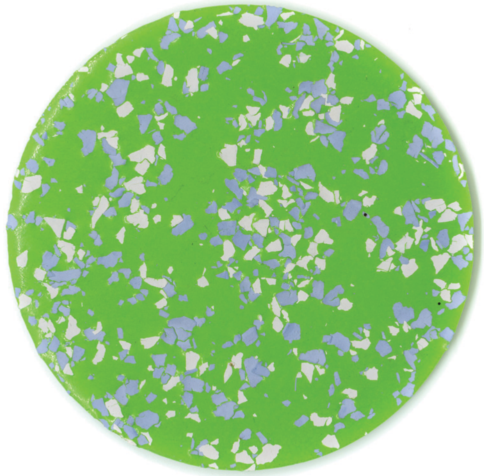


Petri dishes with cultures from contaminated residual waters, tested in the laboratory.

NAME Brenntamer 585
PRODUCT APPLICATIONS wastewater treatment
PROPERTIES Granulated product, easy to dose; contains a process aid that facilitates dissolution in the working medium; high charge density; forms temporary bonds with organic compounds, forming flocs that allow mechanical separation of impurities from treated water; active across a wide pH range (2-11)
COMPOSITION Flocculant and a process aid
ROLE OF COMPONENTS Active substance and auxiliary
ORIGIN Raw materials of synthetic or mineral origin
RESULTING WASTE Packaging contaminated with chemicals + wastewater
WASTE DESTINATION Sent for incineration
INDUSTRY Wastewater treatment
CLIENTS Treatment plants (municipal, industrial)


PROTECTIA
OBLIGATORIE
A URECHILOR



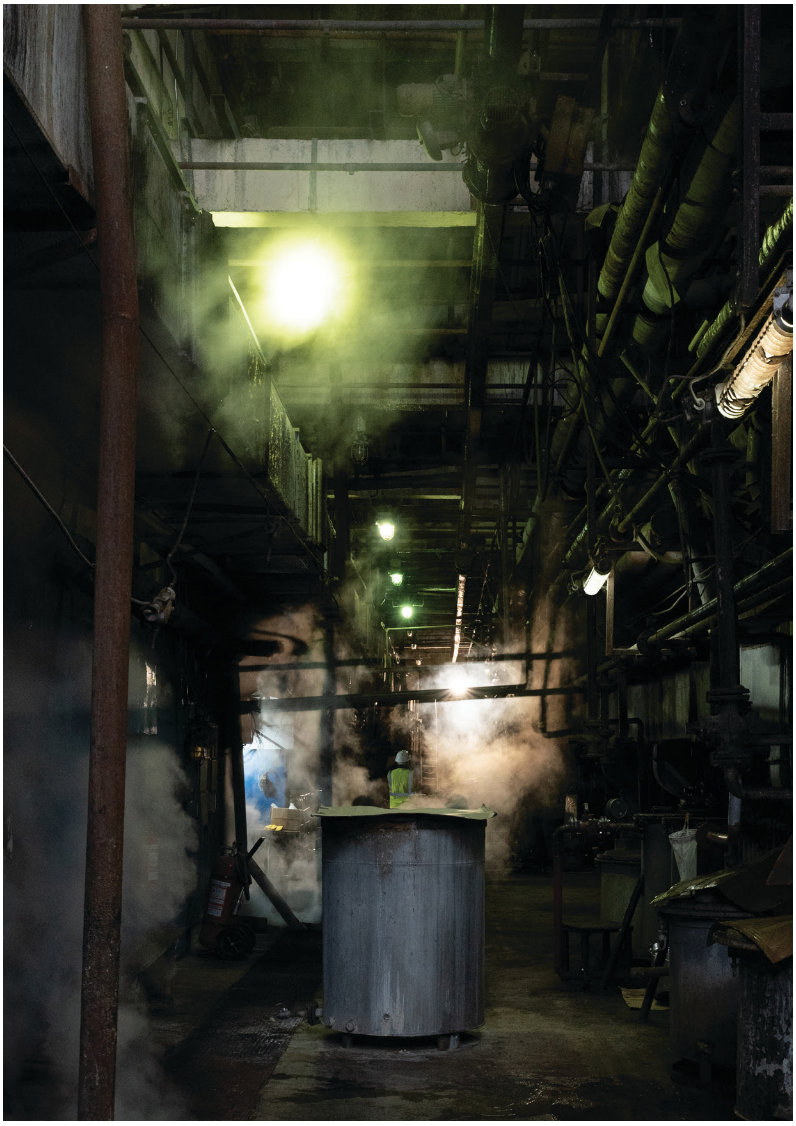


Paint samples developed by AZUR for the Design Signals exhibition furniture in 2023.

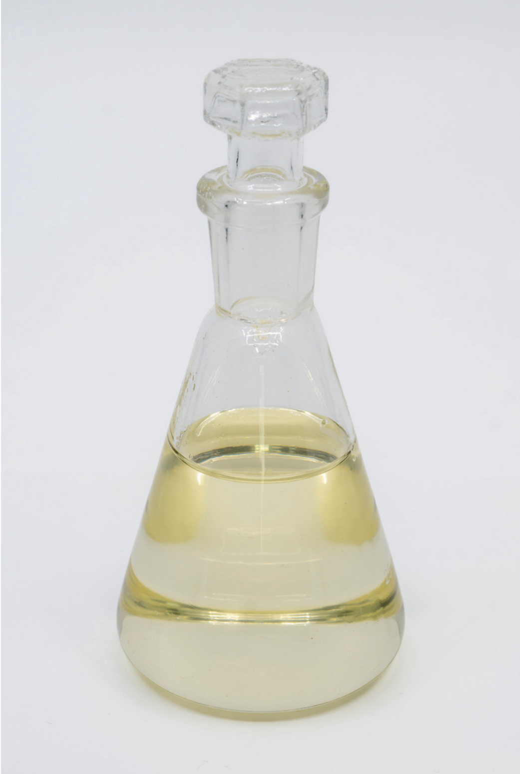
AZUR SA

Azur began operations in 1844 in Timișoara, initially as a candle-making workshop. In 1923, Eugen Farber founded the United Factory of Paints and Varnishes. In 1990, the company underwent restructuring, and in 1999 it was acquired by ICC Industries INC, New York.

The images of Azur were made in 2023 by Marius Vasille.

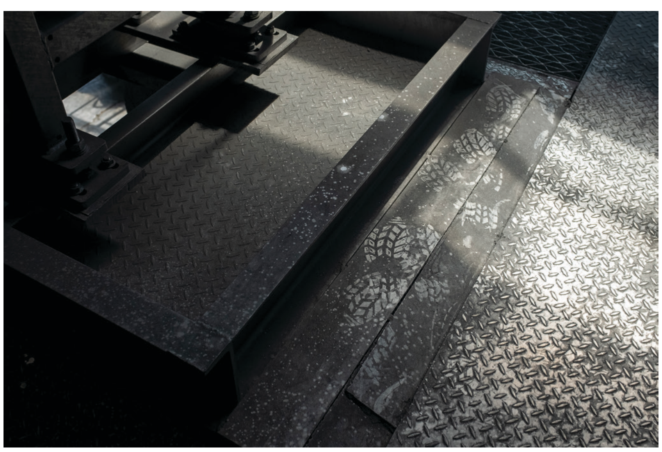


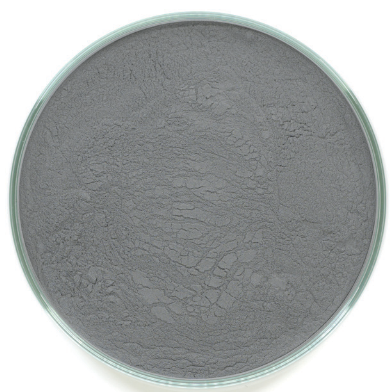
NAME Green apple flavor sample
PRODUCT APPLICATIONS Food, cosmetics, feed, pharmaceuticals
PROPERTIES Nature-identical structure
COMPOSITION Minimum 99% purity
RESULTING WASTE Valorised by combustion at various industrial users
EXPORT EU / non-EU



NAME ALBADECOR liquid aluminum
PRODUCT APPLICATIONS Decorative pigments
COMPOSITION Aluminum 40%, water 60%
INDUSTRY Paints, plastics
CLIENTS Paint manufacturers
ANNUAL PRODUCTION QUANTITY 3600 tons
PRODUCTION TIME / ITEM 24h
WORKERS/ON PRODUCTION LINE 50
PRODUCTION PROCESS Semi-automated

NAME ALUX aluminum powder
PRODUCT APPLICATIONS Aluminum pigments
COMPOSITION Aluminum 99.9%
INDUSTRY Pyrotechnics, paints
CLIENTS Paint manufacturers
ANNUAL PROD. QUANTITY 3600 tons
PRODUCTION TIME/ITEM 24h
WORKERS/ON PRODUCTION LINE 50
PRODUCTION PROCESS Semi-automated
ENERGY RESOURCE Electricity
ENERGY COST/TOTAL PRODUCTION 5%

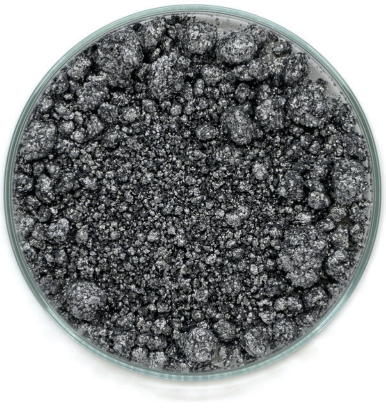




ALBA ALUMINIUM SA

Founded in 1976 on the historic chemical platform in Zlatna, the company initially produced aluminum powders for Romania's lightweight concrete industry. Following privatization in 1999 and the launch of pigment production in 2001, it became an important player in the global lightweight concrete and paint markets, upholding a long-standing tradition while continually investing in innovation.

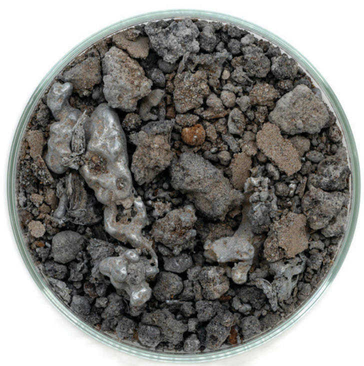
NAME LUNA aluminum paste
PRODUCT APPLICATIONS Automotive industry, decorative pigments
PROPERTIES anticorrosive, decorative, protective
COMPOSITION Aluminum 70%, solvent 30%
RESULTING WASTE downgraded - unusable material
WASTE DESTINATION recycling and destruction companies
INDUSTRY Automotive, decorative
CLIENTS Paint manufacturers
ANNUAL PRODUCTION QUANTITY 3600 tons
PRODUCTION TIME / ITEM 24h
WORKERS/ON PRODUCTIONLINE 50
PRODUCTION PROCESS Semi-automated



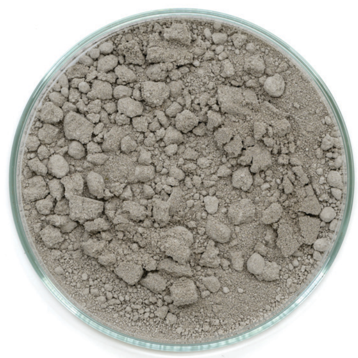
BERG BANAT SRL
A Romanian company established in 1991, specialising in welded metal structures and hot-dip galvanizing. Headquartered in Timișoara, with branches in Făgăraș and Câmpia Turzii, the company uses modern equipment and operates in compliance with international standards. It is ISO 9001 certified and a member of the Romanian National Association of Galvanizers (ANAZ).

Each steel element to be galvanized is first cleaned in an acid bath inside a ventilated room, producing iron oxide as a byproduct.

NAME Acids, wastewater, and a mix of iron, zinc chloride, and ammonium chloride
PRODUCT APPLICATIONS Specialised facilities/companies for recycling/waste disposal
PROPERTIES Acids must be recycled (increasing hydrochloric acid concentration); Wastewater must be neutralized before reuse or disposal; Iron, zinc chloride, and ammonium chloride mixtures disposed of by specialised companies or used as filler and red pigment in the construction industry
COMPOSITION Chlorinated acids, iron, ammonium chloride, and zinc chloride
COMPONENTS role reuse in galvanisation industry
RESULTING WASTE Wastewater, used acids, iron mix, zinc chloride, ammonium chloride
WASTE DESTINATION Internally neutralized / sent to specialised companies
QUANTITY PRODUCTION/YEAR 100 cubic meters
WORKERS ON PRODUCTION LINE 150
PRODUCTION PROCESS Semi-automated; hanging the pieces requires human handling



NAME Zinc ash
PRODUCT APPLICATIONS Recovery of zinc with approx. 98% purity; until recycling, no industrial applications
COMPOSITION Zn, NH,Cl, ZnCl (zinc, ammonium chloride, zinc chloride)
COMPONENTS ROLE Zinc—reintegration into industry; Ammonium chloride—steel industry, batteries, textiles, agriculture, medicine, etc.; Zinc chloride—steel industry, agriculture, chemistry, textiles, etc.
WASTE DESTINATION Resale to businesses
QUANTITY PRODUCTION/YEAR around 100 tons/year
WORKERS ON PRODUCTION LINE 50
PRODUCTION PROCESS Semi-automated; hanging the pieces requires human handling



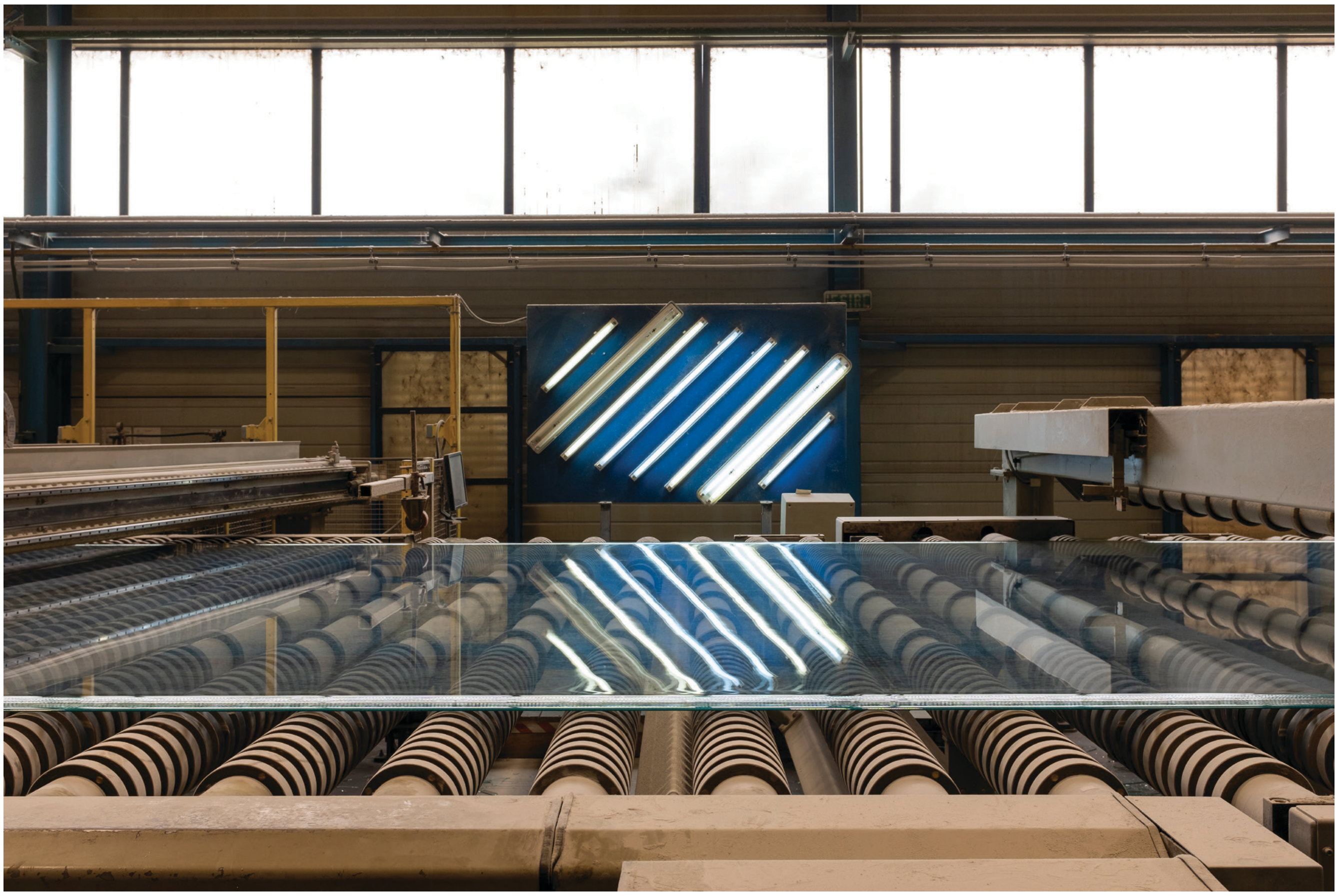
NAME Zinc oxide with no controlled purity and particle geometry
PRODUCT APPLICATIONS Rubber industry (as vulcanization initiator), ceramics (as filler and in glazes), animal feed (as trace element, essential for the digestive tract, especially in the first weeks of life), paint industry (as filler and pigment)
COMPOSITION Zinc oxide and potential chloride residues
RESULTING WASTE Zinc oxide molecules
WASTE DESTINATION Resale to businesses
QUANTITY PRODUCTION/YEAR 2-5 tons/year
WORKERS ON PRODUCTION LINE 150
PRODUCTION PROCESS Semi-automated, since hanging the pieces requires human handling

SAINT GOBAIN SA

Saint-Gobain Glass Romania operates a glass factory in Călărași, where it produces flat glass for architectural facades, residential buildings, and interior design applications. Its product range includes solutions for solar protection, sound insulation, and energy efficiency. In 2019, the company invested several million euros to upgrade its production line, increasing annual capacity to 21 million m^2 while reducing energy consumption by 20%.

NAME Recycled glass powder ORAÉ®
Producer Saint-Gobain Glass
PRODUCT APPLICATIONS Glass for facades and windows
PROPERTIES 6.64 kg of CO, eq./m' for 4 mm glass
COMPOSITION 64% recycled glass vs. the average of 9% in standard products
ROLE OF COMPONENTS Using recycled glass reduces virgin raw material consumption and the energy required for the process
ORIGIN Europe
RESULTING WASTE Glass shards
WASTE DESTINATION Reused in production
INDUSTRY Construction materials
CLIENTS All construction sectors

The glass panels are produced on a continuous production line, from furnace casting to cutting and stacking.



The final glass sheets, each measuring 12 by 6 meters, are ready to be shipped to production facilities.

NAME Rectangle D2 Cement Grey
PRODUCT APPLICATIONS Exterior paving and finishing for pedestrian and vehicular traffic roads
CHARACTERISTIC splitting tensile strength not less than 3.6 MPa, per Romanian Standard SR EN 1338
PROPERTIES Fraction 0-4 63%, Fraction 4-819%, Composition Cement Portland 42.5R 16.9%, Additive 0.1%
ROLE OF COMPONENTS Aggregate (4-8), filling space and forming the mix; Fraction 4-8, material and forms the product structure; Additive reduction of quantity in the material. Fraction 0-4 provides additional volume and envelops the second provides strength and durability; Cement Portland 42.5R binds the material and forms the product structure; Additive: reduction of quantity in the material
ORIGIN Local and Romanian suppliers
RESULTING WASTE Raw material and material waste
WASTE DESTINATION Recycled
INDUSTRY Construction, outdoor landscaping
CLIENTS Individuals/ legal entities
EXPORTS Hungary, Austria
QUANTITY PRODUCED/YEAR 45,000 m^2/year
PRODUCTION TIME/PRODUCT 18 seconds per m'; 50 pcs/m'
WORKERS/PRODUCTION LINE 5 workers/shift
PRODUCTION PROCESS Fully automated
ENERGY RESOURCE Electricity, water
ENERGY COST/TOTAL PRODUCTION 20-25%

Base-mix samples (Fraction 0–4mm)

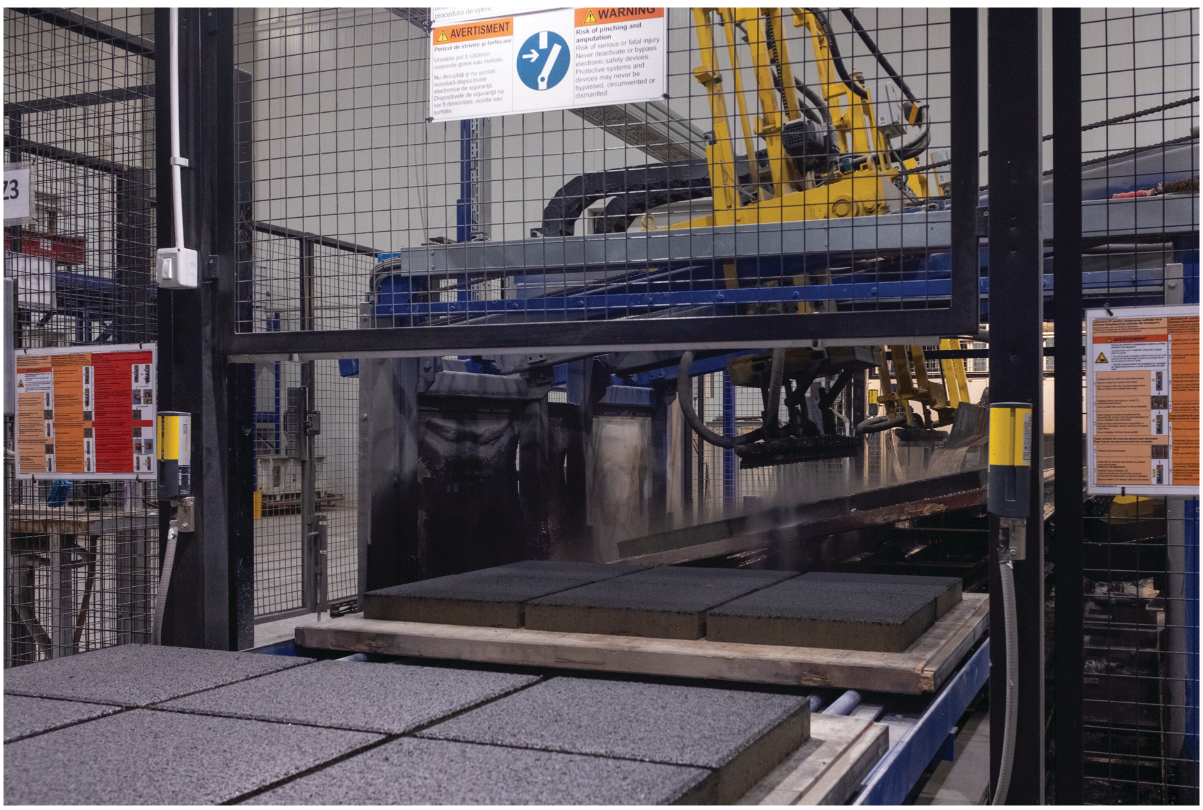
ELIS PAVAJE SRL

Elis Pavaje, founded in 1991 in Sebeș, is Romania's leading producer of concrete pavements, curbs, and landscaping elements. With multiple factories nationwide and a daily capacity of over 20,000 m^2, the company has expanded through continuous investments, supplying both residential and large-scale infrastructure projects.

Base-mix samples (Fraction 0–8mm)

Portland cement 42.5R, Additive

450052



procedura de oprire
AVERTISMENT
Pericol de strivire și forfecare
Urmările pot fi vătămări corporale grave sau mortale.
Nu decuplați și nu șuntați niciodată dispozitivele electronice de siguranță.
Dispozitivele de siguranță nu vor fi demontate, ocolite sau șuntate.
WARNING
Risk of pinching and amputation
Risk of serious or fatal injury.
Never deactivate or bypass electronic safety devices.
Protective systems and devices may never be bypassed, circumvented or dismantled.
Z3

SANEX SA

Sanex SA, part of the Lasselsberger Group, owns and operates the Cesarom brand, a leader in Romania's ceramic tile market. With over 50 years of tradition at its Cluj-Napoca factory, Cesarom produces millions of square meters of ceramic wall and floor tiles each year, serving both the domestic market and export.

NAME Alubit balls (alumina)
PRODUCER Various international suppliers: Xieta (Spain), Bitossi (Italy), China
PRODUCT APPLICATIONS Grinding of raw materials and ceramic glazes
PROPERTIES Used in milling machines

Milling cylinder that uses hundreds of alumina balls for grinding the raw materials.

CERASIL SA
Established in 1993, the company operates in Făgăraş, producing raw materials for the ceramics industry, including frits, glazes, and pigments. In addition to production, it is also involved in importing and trading inorganic chemical products for ceramics and enamels.

A frit is an intermediate material used in the glass and ceramics industry, obtained by melting a mixture of raw materials (such as silica, boron, sodium, and calcium oxides) at high temperatures and rapidly cooling it to form vitreous granules or pellets. Essentially, the frit serves as a stable and uniform base for the production of glass or ceramic glazes, facilitating the dissolution and control of the chemical and physical properties of the final product.

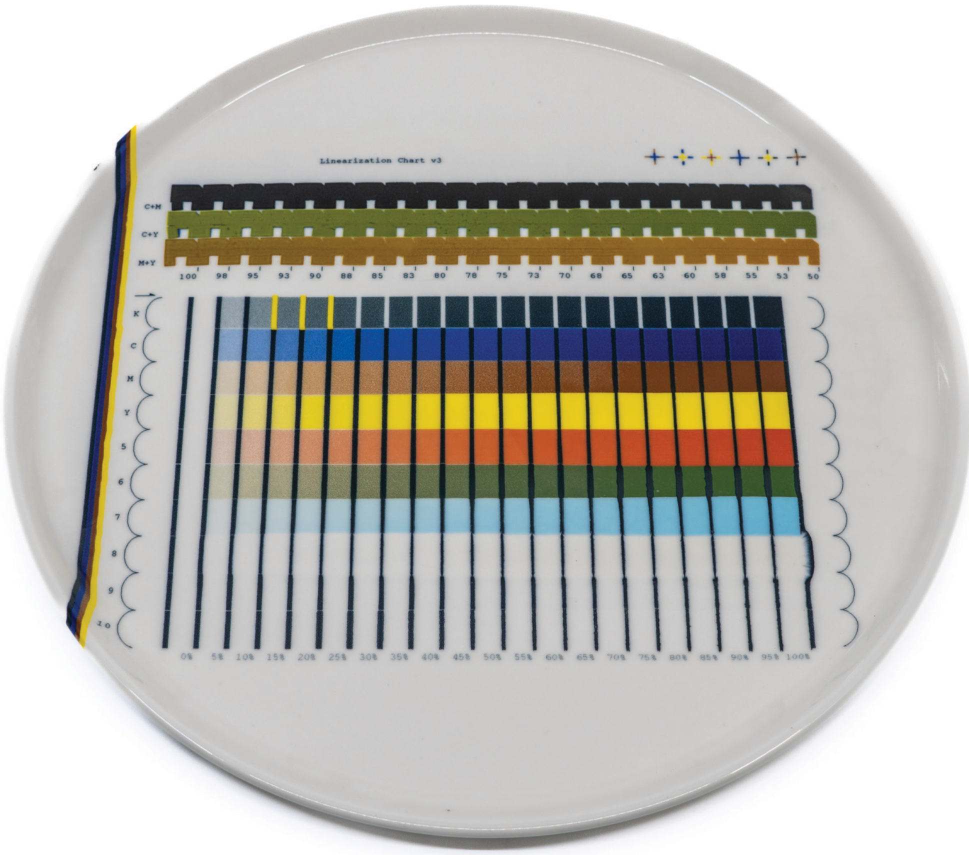

G11.274
negru
24.02.2021
G 10.756
galben
MAHIEU 950
G11.490
verde inchis
MAHIEU 950
G 9327
verde
MAHIEU
G11.387
g
G 468
31.08.2021
G 4604
verde
MAHIEU 950
G11.174
violet
MAHIEU 950
10414
OP 228
G11.489
verde deschis
MAHIEU 950
PC 303

One of the four ovens that IPEC uses to fire ceramic plates, which is 80 meters long and runs continuously.

IPEC SA
Founded in 1990, it is a Romanian producer of household porcelain based in Alba Iulia, and since 1996 has manufactured porcelain objects for Ikea. Its semi-automated production process includes over 350 industrial robots, capable of producing 1.7 million pieces per month—representing 1% of the global plate production.

Fired plate known as ceramic Biscuit, ready for glazing.

Clay mixture for production of ceramic plates.



High-resolution digital colour test on a glazed plate used in IPEC production.

A handmade decorative ceramic bowl, hand-painted and widely popular in Romania during the communist period, produced by Apulum SA, a state-owned company.

IPEC SA produces 50 million plates per year, with a 10% loss, representing 5 million plates that are recycled and reintroduced into production.

PROMATERIS SA
Founded in 1957 in Bucharest (formerly Prodplast SA), the company develops bioplastics and sustainable composites designed for controlled life cycles, ranging from compostable films and bags to innovative materials for packaging, coatings, and construction. By adopting circular practices, such as reusing production waste, the company demonstrates how ecology and industry can come together to create large-scale sustainable solutions.

NAME MaBio HC57P
PRODUCT APPLICATIONS Films, sheets to be converted into finished products such as biodegradable shopping bags, garbage collection bags
PROPERTIES Cylindrical, natural-coloured pellets with a density of 1.3 g/cm^3. The material shows a good balance between elasticity and strength. Finished products made from this material, depending on their thickness, have a tensile strength of 20-30 MPa, elongation at break of 250-400%, and a tear strength of 1-3 N.
COMPOSITION Native corn starch (30-40%), plasticised and compounded with biodegradable polymers
ROLE OF COMPONENTS Plasticised corn starch improves tear resistance properties of the material. Biodegradable polymers are used as matrix and reinforcing materials, providing the necessary mechanical properties (elasticity, rigidity, etc.).
ORIGIN Native corn starch from Romania, biodegradable polymers from various EU and non-EU sources
RESULTING WASTE Biodegradable films and pellets of various colours
WASTE DESTINATION Recycling and reintroduction into the main production
INDUSTRY Biodegradable film manufacturing
CLIENTS Internal use, film-blowing industry
EXPORT Romania or other EU countries
ANNUAL PRODUCED QUANTITY Approx. 4000 tons/year
WORKERS/ON PRODUCTION LINE 3
PRODUCTION PROCESS 65% automated
ENERGY RESOURCE Photovoltaic panels


KARAT
POWERflow

The production line for thin bioplastic film is designed as a vertical system.

Bioplastic granules obtained by recycling the waste sheets resulting from bag production. The colour of the granules comes from the pigment used to print text on the bags.

Selection of interviews with industry experts

ROMCHIMICA ASSOCIATION
Georgiana Surdu
Director of Romchimica Association

PROMATERIS SA
Tudor Georgescu
CEO

AZUR SA
Marc André Fritsche
CEO
Alexandru Mehedințu
COO

CUPRUMIN SA
Mircea Goia
CEO

ALINA PERDIVARĂ
Chemical engineer and PhD Researcher, with over 20 years experience at Azur Paints and Varnishes factory

POLITEHNICA UNIVERSITY OF TIMIȘOARA
Conf. dr. eng. Mircea Laurențiu Dan
Dean of Faculty of Chemical Engineering, Biotechnology and Environmental Protection

NICOLAE BURTAN
Chemical engineer specialised in construction of industrial ceramic ovens.

SALROM SA
Anca Maria Monea
Head of Tourism Department
Matei Constantin
Mining Engineer

TIFEL SRL
Peter Tamas
Owner and administrator
Laszlo Tamas
Founder

BRENNTAG ROMÂNIA
Raluca Pîntea
Regional HSE and Quality Manager

CHIMCOMPLEX SA
Ștefan Vuza
President of Chimcomplex

2.3

Navigating a complex legislative landscape

Romchimica's Georgiana Surdu

Georgiana Surdu is the Executive Director of Romchimica, the Association of Chemical Companies in Romania. She has spent two decades at the intersection of academia and industry, and for the last seven years, has been the primary advocate for the technical, environmental, and legal interests of the Romanian chemical sector. In this interview, she outlines the critical role of chemical advocacy in a complex legislative landscape, the urgent findings of their recent "Transition Pathway" study, and the formidable challenges—from workforce shortages to unrealistic EU deadlines—that define the industry's struggle to survive and transform.

Georgiana, thank you for your time. To start, could you tell us about the role of Romchimica and what a typical advocacy effort looks like for you?

GEORGIANA SURDU
A large part of our work is dedicated to advocacy, primarily dealing with legislative packages from Brussels. The challenge appears when Romanian authorities transpose European legislation into national law. The transposition can be too stringent, or there can be a series of unknowns, as not all people in the ministries are industry specialists. Our role is to guide them, to influence the process for a purpose beneficial to all actors—both inside and outside the chemical industry—so these legislative pieces fit together. A prosperous industry means a prosperous state, with more taxes collected and a stronger, more industrialised economy.

Beyond advocacy, you also focus on sustainability through the Responsible Care program. What does that entail?

This is a voluntary initiative of the global chemical industry—no other industry has something like it. It's a framework for companies to be transparent about their environmental, safety, and security policies and to test their internal limits. We became members in 2020, in the middle of the pandemic, and we are very happy that half of our members have joined. Despite complex problems and heavy workloads, people are interested to see how they can better protect their employees and the environment. This makes us happy as an association.

What would you consider Romchimica's most significant achievement?

I believe the best part is the reopening of discussions about the chemical industry in Romania. In the last 5-6 years, perhaps spurred by the pandemic's need for disinfectants and medical supplies, awareness has grown. This makes us very happy. We'd be even happier if, on this basis, other companies would join us and understand that together we are a stronger voice. As the president of CEFIC says, chemistry is the mother of all industries. The green transition and decarbonisation cannot be realised without taking the chemical industry into account; we are the binder between all other industries.

Your association recently conducted a major study, the "Transition Pathway" for the Romanian chemical industry. What was the impetus for this?

The European Commission called for a mapping of the chemical industry across the EU. While other national associations had existing studies and state support, we could not rely on the same. Studies on the Romanian chemical industry were very old—30 years, or 15-20 at best—and no longer corresponded to current realities like the energy transition or global competition. So, we created a working group, contracted a consultant, and carried out this study over half a year. We presented it to the Romanian authorities at the Prime Minister's Chancellery last May.

What were the study's most critical findings?

We identified a series of critical points, many caused by inconsistent policies over the last 30 years. The first is an increasing dependence on imports. Our exports have decreased every year, creating a dramatic gap in the trade balance. This is regrettable because Romania has raw materials—minerals, unexploited mines of graphite—that could be used by the chemical industry. First, these resources must be mapped. Another way toward sustainability is the reintegration of waste through chemical recycling—of tires for pyrolysis oil, or mattresses to recover polyols. Unfortunately, there are no clear programs for this, and at the European level, there is no clear legislation or funding to motivate such massive investments.

The study also highlights a workforce problem. Can you elaborate?

We are facing a lack of workforce, especially blue-collar workers. There was a legislative and market void for vocational schools from the 1990s until recently. Now, dual education has returned, but the proportion of students is very low—maybe 2,500 maximum complete this track each year. Furthermore, these programs are only in certain centers. I have members in small towns like Zlatna or Râșnov; it doesn't help them if the students are trained in a larger city like Alba Iulia or Brașov, because the young people don't want to move to a small town for work. We need to expand these programs and cooperate with companies and professional associations. You cannot have education without an industrial cluster nearby.

How realistic are the EU's Green Deal targets, such as the 2030 goal for carbon capture and storage (CCS)?

Through a historical allocation, Romania has to capture almost 20% of the EU's total targeted emissions. This is a very high target for a country that is no longer heavily industrialised. And yet, 2030 is totally unrealistic. Companies that should implement CCS infrastructure are still in the feasibility study stage—very far from implementation. We cannot use the existing gas infrastructure to transport CO2, and for safety reasons, we cannot site these projects near localities. The 2030 deadline makes the subsequent 2040 and 2050 climate neutrality goals equally unrealistic. I cannot claim there are completed projects; there are initiatives for less polluting technologies, but the transition is in its very early stages.

There's also the challenge of market acceptance for greener, often more expensive, chemical products.

Exactly. We all might want a 100% vegan, natural cosmetic cream, but we must consider its very short shelf life and its high price. Not many people have the budget for these green products. This brings me back to the policies, which were designed without sufficiently consulting professional associations or considering different population samples. States in Northern and Western Europe are more prepared, both financially and in terms of public information. This is not the case in Eastern Europe, in Romania.

A third thing I observe is a more nationalist spirit; consumers are more inclined toward local products. In Romania, the price is always what makes the difference. It doesn't matter if it's a local brand; if an imported product is cheaper, it will be bought.

Finally, the chemical industry in Romania seems fragmented across different sub-sector associations. Is this a weakness?

It is. We have associations for cosmetics, detergents, plastics, paints... The basic topics and the most important legislation are 90% the same for all of them. It would be more beneficial to merge into a federation or a chamber of commerce. This would allow for specialised personnel and a larger staff, like our colleagues in Poland have.

2.4

Getting ahead of the Green Deal

Promateris's Tudor Georgescu

In the heart of Romania, a company born from the state-owned industrial giants of the communist era is now betting big on the future of European sustainability. Tudor Georgescu, the General Director of Promateris, isn't just following the Green Deal—he's aiming to stay several steps ahead of it, transforming local corn into compostable solutions for cities from Vienna to Copenhagen. In this interview, he shares his vision for a bioeconomic future, the stark realities of building a champion for innovation, and why the greatest risk to his business isn't competition, but the struggle to find a local workforce.

Mr. Georgescu, thank you for speaking with us. Could you introduce yourself and tell us about Promateris?

TUDOR GEORGESCU
My name is Tudor Georgescu, and I am the General Director of Promateris. We are one of Europe's leading manufacturers of packaging made from bioplastic materials and the raw materials themselves. A key differentiator for us is that we are fully integrated under one roof—we produce everything necessary for packaging manufacturing in-house. I'm 38 and have been with the company for over a decade, leading a transformation that has completely reinvented the business.

The company has a long history, dating back to 1957. How has this legacy shaped the modern Promateris?

The company was originally a state-owned enterprise called Mase Plastice, one of the largest plastic manufacturers in the Eastern Bloc. It went through several iterations, but when I took over, we moved to our current location in Buftea and executed a full rebranding to Promateris. While the products, equipment, and business model have been completely transformed, part of the company's cultural heritage—its human resources and skill sets—remains. Ours is a story of transformation from an unprofitable, inefficient producer of all kinds of plastics to a market leader in the new bioeconomy.

What is the core of your business model today?

We built our model around the European push for sustainability, particularly regulations like the PPWR (Packaging and Packaging Waste Regulation), which will mandate compostable materials for a range of products like thin plastic bags, coffee capsules, and fruit stickers. The goal is for these materials to be recycled with bio-waste. We create packaging that performs perfectly in composting conditions. We started with finished products like bags for the selective collection of bio-waste—you can find our bags in cities like Vienna, Copenhagen, and Bratislava. Now, we are among the top 3-5 specialised companies in Europe for these products.

You mentioned full integration. What does that entail?

After establishing ourselves in the bag market, we began producing our own raw material: granules made from corn starch and polymers. This is a highly efficient part of our operation, as the corn starch is sourced locally from Romania, one of Europe's largest producers. We've created a supply chain that turns local agricultural resources into high-value raw materials. These granules have multiple applications, from waste collection bags to biodegradable agricultural films. We're even innovating further by integrating fertilisers and vitamins into these films to support plant growth.

This sounds highly innovative. What is the role of R&D at Promateris?

It's absolutely crucial. In a national context where research has declined, we were determined to restart this engine. We created a research department and were fortunate to attract young, specialised professionals who wanted to return to Romania. This, coupled with significant CAPEX investments—over €30 million in top-tier technology from Western Europe—has allowed us to develop everything we have today. Our core process is extrusion cooking, and through R&D, we've mastered how to think about, process, and combine materials to create these innovative products.

How do you view the role of traditional plastic versus bioplastic?

We are rational people. Plastic is an essential material for modern life—from medical supplies to sanitation and electrification. It's not a bad material; it's extraordinary. The problem is its overuse in single-use applications. For these, alternatives exist. We don't see paper or pulp as the most sustainable options in many cases. However, for specific applications like organic waste collection, bioplastic performs extremely well. It's made from renewable resources, can be composted with the waste, and offers a superior end-of-life process. Each application has its place, and for bio-waste, compostable bioplastic is the right material.

What do you see as the major opportunities and risks for your industry?

The major opportunity is the intelligent valorisation of local agricultural resources. By moving from selling raw materials to producing high-value-added goods locally, we can contribute to GDP, create better jobs, and improve environmental impact. This is a major opportunity for a Romanian export champion.

The major risk is the increasing inability to hire a local technical workforce. Today, we import almost 50% of our workforce. We've built a wonderful, multicultural team, but we are concerned about the long-term sustainability of relying on people who may one day decide to return home. For a company rooted here, that is a significant risk.

How does your work align with the European Green Deal?

We started this business to embody the spirit of the Green Deal—sustainability, innovation, and the bioeconomy. We don't just follow regulations; we aim to anticipate them. If there are discussions about compostable fruit labels, we are already developing them. We follow these legislative initiatives with curiosity and enthusiasm, seeing them as real opportunities for progress. We are already working with next-generation materials like PHA, a biopolymer that biodegrades in all environments.

Has the Romanian state supported your initiative?

Frankly, based on our experience, we haven't benefited from meaningful state support. A significant part of our investment, between €3 and €5 million, came from the Norwegian Government through grant programs focused on environmental policies. That helped us tremendously. In contrast, our competitors in countries like Italy often have a large share of their investments supported by national programs. In Romania, we have yet to find the right structure to access similar support. The impact of the Romanian state on our development has been essentially nonexistent.

Finally, as an entrepreneur and shareholder, how do you view the future?

I am fundamentally entrepreneurial; I enjoy building businesses, assessing risks, and creating agile teams. However, I look ahead with some concern. As Romania seems to become dominated by a handful of multinationals, I wonder what the future holds for entrepreneurs. Will we become small robots in systems controlled by large funds, with limited freedom and creative drive? I would like to see more examples like ours in Romania—companies that keep the entrepreneurial spirit alive.

2.5

What Was, What Is, What Will Be

Nicolae Burtan and Romanian ceramics

Nicolae Burtan is an engineer whose life maps onto the industrial history of Romanian ceramics. From his graduation during a period of foreign investment and technological influx, through his central role in building major porcelain factories in Alba Iulia and Curtea de Argeș during the communist era, to his later career as a university professor and private consultant after the 1989 revolution, Burtan has been a first-hand witness to the growth, stagnation, and eventual collapse of an entire industrial sector. In this wide-ranging conversation, he offers a detailed, region-by-region autopsy of the Romanian ceramics industry, identifying the causes of its decline—from misguided policies and lost strategic assets to a critical failure in education—while pointing to the rare, inspiring examples of resilience that offer a fragile hope for the future.

Mr. Burtan, your career spans the entire modern history of the Romanian ceramics industry. Could you tell us about your start and what shaped your path as an engineer?

Our generation became engineers at a time of foreign investment from prestigious companies, which helped not just ceramics, but all chemical industries. I was from Turnu Măgurele, where a fertiliser plant was being built, and I thought I might work there. But in the dorm, older students told me, "Go to Silicates—it's a new industry, still being researched—it has great potential." So, my friend and I went, and it was a great decision. It was an excellent school; we studied everything thoroughly, with good internships and solid courses. I was also lucky to learn German, which I used throughout my life working with foreign companies.

You were involved in major industrial projects from the very beginning, even creating an invention early in your career.

In communist Romania, graduates were assigned to cities and workplaces by the state. I was assigned to UCM Reșița, to the research laboratory. In my first seven months, I worked on a project that resulted in an invention: a fluid ceramic mixture for foundry work used to cast the propellers for the Iron Gates, which is a gorge on the Danube River, between Romania and Serbia, with a dam and a hydroelectric power station. The project was patented. But when I went to the foundry to apply it, I realised industry wasn't for me—it would be a pity to forget what I had learned without mastering the practical side. I spoke to my professors, and they said, "Burtan, go to Alba Iulia. They're building a new porcelain factory there with German companies. You and your wife both know German. Go and make something of it." And so we went.

This began a period where you rose quickly, becoming a director and building factories across the country. What was the secret to this progress?

I was incredibly fortunate to have remarkable people around me—people I could learn from in every direction: above me, beside me, and below me. I learned from everyone. That was my great fortune. When we met years later, my colleagues would say, "Man, you were really lucky." And yes, by chance, I was the one who got promoted. But it was through work. I started in Alba Iulia, and in December 1971, on my birthday, I was appointed chief engineer for production. Soon after, I was sent to Curtea de Argeș as director to build another factory. I received a waiver from Ceaușescu himself for the position, as I didn't have the required ten years of experience.

After the 1989 revolution, you moved to academia and later started your own company. What did you observe in the industry during this turbulent transition?

After the revolution, starting in '92, a kind of frenzy took over. I counted 157 private ceramic companies established. Everyone was making vases, figurines, tableware products. It was madness. At this point, only one of those 157 is still operating. The industry doesn't work at such a small, artisanal scale. I advised many that they couldn't compete without the scope and capital required. The proof is clear.

You have undertaken a meticulous, region-by-region mapping of the industry's fate. In the Banat area, what is the situation?

In Lugoj, the old brick and tile factory, now Mondial belonging to Villeroy & Boch, is the only one still doing well, though it now produces sanitaryware. The other factories in Jimbolia, Cărpiniș, Biled, and Găvojdia are all closed, their sites abandoned or repurposed. The most modern factory in Chizătău, which had the only mechanised loading system in the country, was also shut down. In Timiș County, in Banat, the only factory left is Mondial Lugoj. All the others are black dots on the map—dead. I'm sorry to say it, but that's how it is.

And in other regions, like Crișana, Bihor or Maramureș?

There are still some functioning factories. In Zalău, the Cemacon factory, now acquired by Dedeman, is a pride—the largest in capacity. There is also a terracotta factory in Vadul Crișului and one in Salonta and the Helios refractory plant in Aleșd. But we suffered a tremendous strategic loss in Oradea: the tabular alumina factory. Tabular alumina is a top-tier material for rocket linings and advanced steelmaking. The

Russians took over the alumina plant and moved the entire production line to Russia. They are smart, and we were foolish. How could we give away such advanced technology? It's shut down, gone, erased.

The picture you paint is largely one of decline, but you also point to inspiring exceptions, like the IPEC factory in Alba Iulia.

IPEC is one of the largest tableware ceramics factories in the world, with over 350 robots. The Covaciu family had a clear vision and focused on large-scale production and automation. I truly admire them. They started from zero, from something small in their backyard. What I also admire is their business acumen. They secured the right to sell to clients other than IKEA. I heard from Cristian (Covaciu, owner and CEO of IPEC) that 32% of their physical production brought in 52% of their revenue—and not from IKEA. This family is extremely inspired, well-organised, and an example to follow. You've never heard of any scandal or fraud involving them.

Looking at the entire sector, what is the realistic future for Romanian ceramics?

We must divide it into three parts. First, the ceramic construction materials industry—bricks and tiles. This has potential. We have the raw materials, and the surviving factories must be modernised and fully mechanised to survive. Second, tableware ceramics. Here, we cannot compete. We are flooded with Chinese goods, and we no longer have the domestic raw materials—the high-quality sands, feldspars, and kaolins are gone. The third branch is technical ceramics, for insulators and specialised components. I believe we've missed the train here as well; we lack the raw materials and the scale.

So, the only branch with a real perspective is the construction ceramics industry. That is the one that can still make sense.

A recurring theme in your analysis is the critical lack of a skilled workforce.

Where is the Professional High School in Alba Iulia? Where is the Master Technicians' School in Turda? They're gone. We don't have them anymore. When I worked in this industry, I used to train my own people. I had places to do that. They learned. But if we don't take care of the living part of the factories, we will smell death far too often. We need people, from top-level engineers to the most skilled workers. The human contribution hasn't disappeared; there is still a great need. But where are they now?

In conclusion, how do you feel about efforts to place a new spotlight on the Romanian ceramic industry?

I appreciate that you're taking an interest in things that many who should be doing this rarely care about. I value the fact that you care—about what was, what is, and especially what will be.

The Ceramic Industry

Overview of the evolution of the ceramic industry in Romania, provided by Nicolae Burtan

Geographical Areas from Southwest / South / Southeast

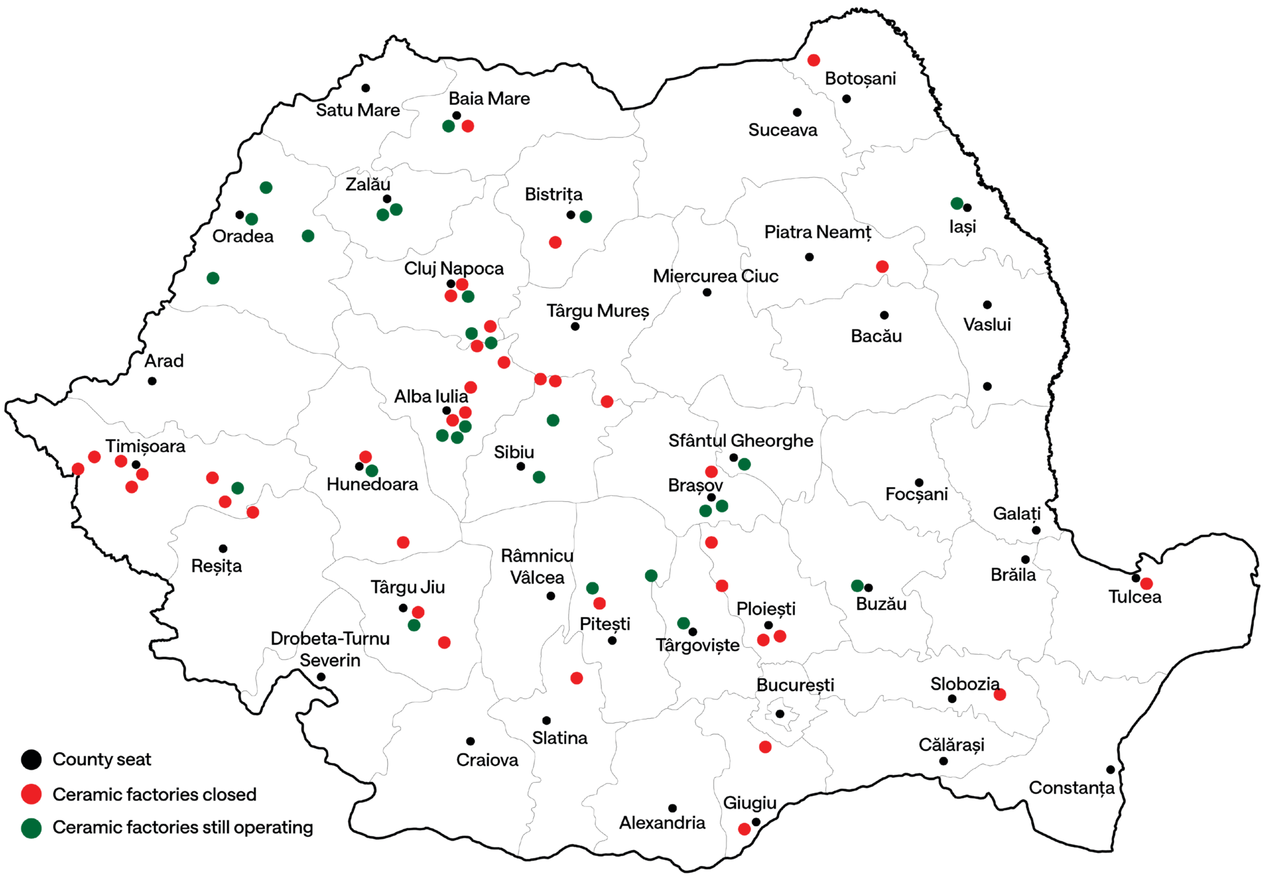
	Geographical Area	Profile or Manufacturing Unit	Name of Brands	Steps in the Emergence and Development		
				Century XVII/ XIX	1900 - 1947	>1947 >1989
A	Oltenia					
1	Târgu Jiu (GJ)	Bricks	MACOFIL			>1980 >2000
2	Târgu Jiu (GJ)	Bricks	Fibrocim			>1996
3	Târgu Cărbunești (GJ)	Bricks	-			>1950
B	Muntenia					
1	Câmpulung Muscel (AG)	Bricks	Ceramus			>1950 / >2009
2	Doicești (DB)	Bricks	Soceram, Wieneberger			
3	Curtea de Argeș (AG)	Household porcelain	Arpo			>1950 / > 2019
		Terracotta	GMV			1971
4	Pădurețu (AG)	Bricks	-			2009
5	București (B)	Ceramic Tiles	Cesarom			2008
		Sanitary porcelain	ROCA			1950
6	Pleașa - Ploiești (PH)	Refractories	Real		1918	1975/>1980
7	Bucov - Ploiești (PH)	Refractories	1 MAI			>1975
8	Comarnic (PH)	Refractories	Vulturul		>1920	>1960/ >1980
		Technical ceramics	-			
9	Azuga (PH)	Refractory fireclay	Sinterref			>1950/ >1989
		Sintered corundum	-			
10	Giurgiu (GR)	Bricks / Terracotta	Dunaprefi			>1995
11	Sătuc / Buzău (BZ)	Bricks	Wienerberger			>1950/>2018
12	Făurei (BR)	Bricks	-			>1950
13	Țăndărei (IL)	Bricks / Tiles	-			>1970
C	Dobrogea					
1	Tulcea (TL)	Basic Refractories	-			>1970

Geographical Areas from East / Northeast

A	Bucovina					
1	Dorohoi (BT)	Household ceramics	-			>1978
B	IAȘI / Neamț					
1	Iași (IS)	Bricks	Brikston			>1980/ >2008
			Keier			>2020
2	Roman (NT)	Bricks	Romanceram			>1955 / 1991
		Sanitary procelain /	Cersanit			>2008
		Terracotta	-			

Gheographical areas from West / Northwest / Centre

	Geographical Area	Profile/ Manufacturing Unit	Name of Brands	Steps in the Emergence and Development		
				Century XVII/ XIX	1900 - 1947	>1947 >1989
A	Banat					
1	Lugoj (TM)	Bricks/ Tiles	Muschong Mondial	1883		
		Sanitary ware	Villeroy & Boch			>1970
3	Lugoj - Herendești (TM)	Bricks	-			>1950
4	Jimbolia (TM)	Bricks / Tiles	Bohn & Co, Kerachit	<1880		“>1960
5	Timişoara (TM)	Terracotta	Extraceram			>1996”
6	Timişoara (TM)	Technical ceramics	Crinul			>1950
7	Chizătău (TM)	Bricks / Terracotta	Extraceram			>1950
8	Cârpiniş (TM)	Bricks	Muschong, Bohn & Co	<1880		>1960/ >2000
9	Biled (TM)	Bricks	-			
10	Găvojdia (TM)	Bricks	-			
B	Crişana - Bihor					
1	Zălău - Recea (SJ)	Bricks/ Bricks	Cemacon (Dedeman) Eurobrick (Cemacon - Dedeman)	1883		>1950 / >2000
2	Biharia (BH)	Bricks	-	<1880		>2000
3	Vadu Crişului (BH)	Terracotta	-			>1990
4	Aleşd (BH)	Refractory bricks	-			>1950
		Bricks	Helios			
5	Oradea (BH)	Tabular alumina	Alor	<1880		>1985
6	Salonta (BH)	Terracotta	Terasal			>2000
C	Maramureş					
1	Baia Mare (MM)	Household tiles	Faimar			>1978
2	Baia Mare (MM)	Household ceramics	Ceramar			>1990
D	Cluj					
1	Cluj-Napoca (CJ)	household porcelain / Vitrus	IRIS			>1978 >1990
2	Cluj-Napoca (CJ)	Ceramic tiles/ sanitary ware	Samex			
3	Cluj-Napoca (CJ)	Domestic porcelain	(Moga)			
4	Dej (CJ)	Basic Refractories				
		Technical ceramics / Isolators	Electroceramica I			
5	Turda (CJ)	Technical ceramics / Insulators	Electroceramica II / Lapp Insulators			
6	Turda (CJ)	Silica Refractories	9Mai / Casirom			
		Silicon carbide	Casirom			
7	Turda (CJ)	Technical ceramics	Cerasind			
8	Câmpia Turzii (CJ)	Bricks	Wienerberger			
E	Bistriţa - Mureş - Sibiu					
1	Târnăveni (MS)	Bricks	Cars	1918		
2	Târnăveni (MS)	Household wall tiles	-			>1995
3	Sighişoara (MS)	Household wall tiles	Cesiro			>1955 / >1996, >2000
4	Mediaş (SB)	Terracotta	Teracota Mediaş		1906	>1950
5	Livezile (Bistriţa) (BN)	Terracotta	Teraforce			1995
6	Lechinţa (BN)	Bricks	-			>1960
7	Lunca Mureşului (AB)	Bricks	-			>1960
8	Sibiu (SB)	Bricks / Tiles	Tondach		>1950	>2000



F	Harghita - Covasna - Brașov				
1	Sfântu Gheorghe (CV)	Terracotta	-		>1998
2	Brașov (BV)	Refractories	Răsăritul, Refarom	>1950	>1978
3	Cristian (BV)	Refractories	Refarom		>1955
4	Feldioara (BV)	Bricks	-	>1900	
G	Alba - Hunedoara				
1	Alba Iulia (AB)	Refractory	Refractara		>1960
2	Alba Iulia (AB)	Household porcelain/ Vitrus	Arpo -z		1970
3	Alba Iulia (AB)	Household porcelain	IPEC (Covaci)		>1996 / >2010
4	Alba Iulia (AB)	Household porcelain/ Vitrus	Axa Porcelaine (Sarmeș)		>1992
5	Micești (AB)	Household porcelain	(Luca)		>1992
6	Aiud (AB)	Household porcelain	-		>1992
7	Deva (HD)	Household porcelain	-		>1992
8	Bîrcea Mare (HD)	Terracotta	-		>1960
9	Sântimbru (AB)	Bricks	Teracota Deva		>1950
10	Baru Mare (HD)	Refractories	-		>1955 / >1980
11	Aiud (AB)	Bricks	-		>1998

3

Chemical Bonds Exhibition

3.1

Design Signals —Chemical Bonds

Traversing a Fragmented Landscape

Chemistry is both a science of transformation and a structure of control. It governs the materials that shape our world—through bonds forged between atoms, and through policies, patents, and industrial standards. Its industry supports countless others, from agriculture to automotive, from textiles to tech. At the same time, the sector is weighed down by stigma—often perceived as a polluting, extractive force—when it is foundational to modern life. But in Romania, the chemical sector also reveals a system in crisis: fragmented infrastructure, underused expertise, and limited space for innovation.

Design Signals—Chemical Bonds confronts this tension. It asks what kinds of design practices are possible when access is restricted, when knowledge is siloed, and when an entire industry operates at the thresholds of visibility. Designers, researchers, companies, and institutions come together to trace how material, labour, and expertise circulate—or stall—across the chemical landscape.

This begins with research: a report by sociologist Norbert Petrovici maps the disintegration of Romania's once-integrated chemical platforms and the regulatory and structural barriers that prevent innovation. A second phase followed on the ground: over twenty site visits produced interviews, photographs, and documentation that reveal everyday strategies of maintenance, care, and adaptation.

The commissioned design projects work within this complexity: glaze as forensic tool, salt as industrial ritual, bioplastics as surface, and galvanisation as gesture. Also on display are outcomes from a schools programme, where design students and tutors explored chemistry's role in daily life; and a journalistic collaboration investigating Romania's position in Europe's green transition—particularly around resource extraction and industrial policy.

Hosted in the former Azur factory, once a soap and varnish production site, the exhibition is designed from repurposed tiles and structural components sourced from chemical facilities. It operates as a lab, archive, and site of public engagement—where design helps make hidden bonds visible, and perhaps renegotiable.

Design Signals—Chemical Bonds does not offer solutions. Instead, it opens a space where new interdependencies might take root. In a sector marked by systemic problems, design is not used to simplify complexity, but to pose deeper questions about how we live with chemistry. The responses are not always clean. But they are necessary.

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3.2.1

Salt in Motion

The Body's Ionic Exchange

Gaia D'Arrigo

Salt is a mineral present across biological, ecological, and chemical systems. Salt in Motion is an interactive installation that explores the connection between the Romanian saline landscape, the human body and healing practices linked to salt mines and springs. It features a halogenerator system from PRIZMA combining salt rocks from the Ocnele Mari mine. The device disperses aerosolised salt in controlled environments, a wellness treatment rooted in speleotherapy–the exposure to salt mine microclimates known to benefit respiratory conditions.

A brine-filled tank recalls the tradition of salt bathing at springs, where locals once collected brine for domestic use and therapeutic soaking. The installation also includes a reconstruction of briquetage salt containers, based on fragments discovered at the Valea Sărată–Gherla site by Gaia and the ethnoarcheologist Marius Alexianu.

Presented alongside salt in its industrially recognised forms—raw material, technical grade, and pharmaceutical purity—the work reveals how this compound, so embedded in daily life that it becomes invisible, is continuously refined, regulated, and ritualised. Salt becomes not only substance, but vector: shaping bodies, landscapes, and infrastructures.

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PROGRAMMING Andrei Ionescu

BIOS

Gaia D'Arrigo is a Rotterdam-based designer and artist from Italy. Her work investigates the material manifestations of toxicity, contamination, and industrial transformation, often through immersive installations and speculative devices.

Marius Alexianu is an ethnoarchaeologist and professor at the "Alexandru Ioan Cuza" University of Iași. He is a leading scholar on the anthropology of salt, having directed multiple research projects on the cultural, ritual, and technological practices surrounding salt in Romania from prehistory to the present.

3.2.2

Salt of the Earth

An Interview with Gaia D'Arrigo on Salt, Myth and Material Ecology

Salt in Motion: The Body's Ionic Exchange sees Rotterdam-based designer and researcher Gaia D'Arrigo explore the profound yet overlooked significance of salt, drawing on field work in Transylvanian mines and collaborations with ethno-archaeologists and industrial partners. Through her practice of investigating how production systems and culture manifest in the material world, D'Arrigo examines salt through the critical lenses of toxicity and contamination. In this interview, she speaks about her multidisciplinary process—which blends situated research with fact-fictional storytelling—and how ancient myths and modern chemistry inform her work.

Her interactive installation is the culmination of this research for the 2025 edition of FABER's Design Signals program. The work transforms a medical halogenerator into a central artistic element, using transparent tubing to connect it to a salt-block mask. Activated by a viewer's proximity, the system releases aerosolised salt particles, creating a visceral experience that bridges traditional healing practices—from salt spring soaking to speleotherapy—with the material's modern industrial grades and commodified forms. Nadine Botha spoke to her as well as her collaborator, ethno-archeologist Marius Alexianu, on why this essential mineral offers a critical lens for understanding our relationship to the environment, the body, and the hidden socio-environmental narratives that shape our world.

It's great to chat to you about your installation, Gaia. Your practice repeatedly returns to salt as a medium. What is it about this material that holds such a persistent fascination for you?

GAIA D'ARRIGO
Salt represents balance. In different projects, I've encountered it as both a beneficial agent and a toxic one, depending on the context. I'm drawn to its hygroscopic nature—its chemical capacity to absorb humidity—which contributes to its perception as a kind of 'magic' material, beneficial for both the environment and the human body. This project continues that core investigation: analyzing salt's chemical processes alongside the cultural imaginaries it creates. I'm interested in this balance; in excess, it's extremely toxic, but in the right

Field research pictures courtesy of Gaia D'Arrigo.

quantity, whether in the body, soil, or air, it reacts with other materials and becomes extremely beneficial. This duality is my starting point.

Your work masterfully layers the biological, chemical, industrial, and mythical. How do you approach building these narratives so they expand rather than flatten into a single story?

I always try to find a hook—an image people can relate to and access. For instance, with a previous project on pollution in Milan, I started by looking at the urban context, its history, and the politics, then zoomed into the material itself. Both pollution and salt are often invisible materials, found in particles. I look at their chemical characteristics, how they exist in the environment, and how the body relates to them, creating a hybrid narrative that connects these three aspects. I often use a literal embodiment of this relation. What does it mean to embody an environment, especially when it's toxic? This project follows a similar method: a specific environment (Romania's salt landscapes), a material that reacts with both the environment and the body, and the cultural traditions of its use.

Mythology and alchemy seem to be powerful lenses in your work. What is it about these frameworks that helps you explain complex phenomena?

I love that mythology allows for different layers of meaning to coexist simultaneously. The importance isn't related to what is strictly true or false. In a complex narrative, this allows me to create layers of meaning so an audience can relate to or capture some of them—or all. Mythology has always been a way to explain phenomena. And with alchemy, my big love is that it used scientific, spiritual, and psychological domains all at once. What fascinates me is that these three aspects could coexist in what was considered a science. Contemporary chemistry has less emphasis on its symbolic value; it's categorised. I hope my practice can create bridges between these disciplines.

The installation invites a visceral, bodily experience with salt in all its states: solid rock, liquid brine, and aerosol particles. What do

you want the audience to feel or question in this space?

I feel there is something about experiencing a material in your own skin, in your own body, that is a powerful tool for connection. The installation features a halo generator—a machine used in modern halotherapy that grinds pharmaceutical-grade salt into particles for inhalation, simulating the effect of a day at the beach or in a salt mine. This connects to a mask, allowing people to inhale the particles. Alongside this is a large tank with a crystallising brine solution, reconstructing those historical vessels. I want to highlight the value and narrative of this material, which is so present yet so given for granted. We see it every day but don't recognise its profound importance in our lives, from food preservation to industrial processes.

You engaged with industry partners, from state-owned salt mines (Salrom) to chemical distributors. What did you learn about the industry's structure and the "invisibility" of salt within it?

Tracing the full chain was essential. We started with the raw material and followed it through extraction, retail, and industrial use. It was impressive to see how many industries use it: water treatment, food, disinfectants, de-icing, medical, and wellness. But in each step of the way, we gained something and lost something. At the mine, there is knowledge of the history, the geology, the site, and the invisible labour. When it gets to a stockist or retailer, it stops being a mineral from an underground cave and becomes chlorine or a chemical among other chemicals. It loses its history and relation to the site. The invisibility is also due to the material's reactivity—it transmutes and changes form. I was even looking at research on where salt aerosols go when they evaporate in the air.

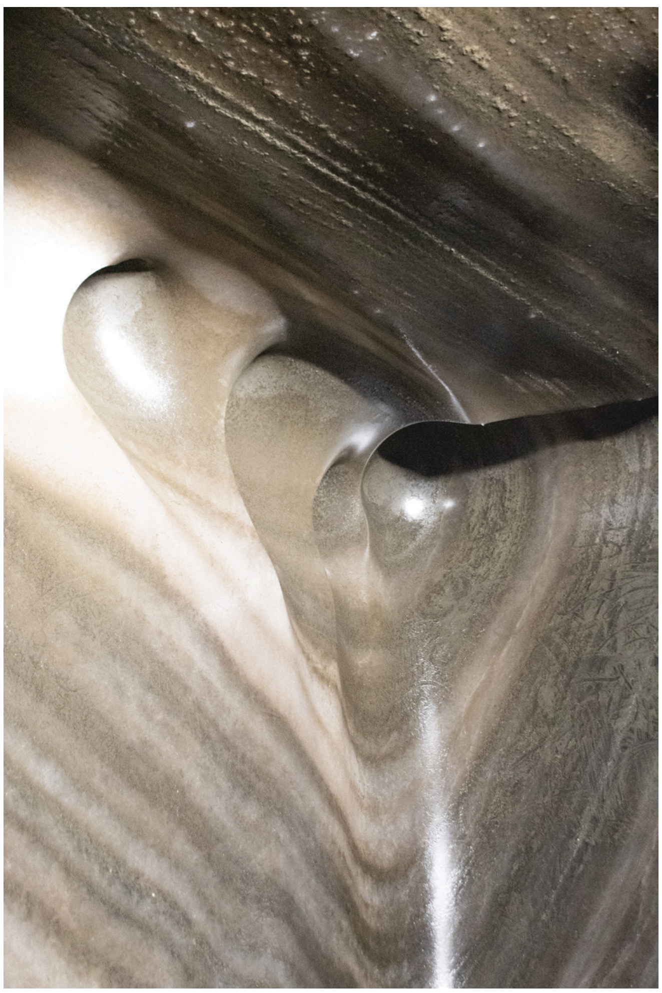
Norbert Petrovici's research, which underpins this exhibition, talks about "residual knowledge" in Romania's chemical industry—expertise that is overlooked or stuck after the fragmentation of the socialist-era integrated system. Did you encounter this in your research?

I saw it in the way knowledge becomes segregated. There is a disconnection between the historical, geological knowledge held at the extraction site and the purely chemical, application-based knowledge at the end of the chain. The value of the material is in its commodification, but the process of commodification itself hides the journey. In the past, the practices surrounding salt were an open, explicit system to the people and community using it. Now, it's a very hidden process. We don't know where it comes from. In both cases, it's a commodity, but once, you were at the center of the process. My project is about highlighting that value and making that hidden journey visible again, reconnecting the residue of knowledge with the material itself.

This project is deeply rooted in Romanian salt landscapes and healing practices. How did your engagement with the place, and specifically with ethno-archaeologist Marius Alexianu shape the work?

Meeting Marius was pivotal. I've never met someone so passionate about salt. His work is a very holistic, interdisciplinary, and warm approach to archaeology. He creates mapping systems to see how populations developed around natural salt sources, which roads emerged, and how societies were built. He joined me in Transylvania, showing me salt lakes with fragments of vessels from the Bronze Age still used for therapeutic soaking. His research is about not looking at a material as an isolated agent, but according to where it's situated and who interacts with it. He narrates a story. This rounded, situated research was a huge influence. The installation explicitly reconstructs the tage—ceramic pots used historically to collect brine—based directly on his work.

Field research pictures courtesy of Gaia D'Arrigo.



Field research pictures courtesy of Gaia D'Arrigo.

Thanks for speaking to us, Marius. Your work has fundamentally shaped a new field: the anthropology of salt. Can you describe what this discipline encompasses and how it came to be?

MARIUS ALEXIANU
The anthropology of salt does not deal solely with archaeology; it encompasses all disciplines whose object of study is salt. I attempted to structure these disciplines according to types of human behavior toward salt, defining cognitive, spiritual, pragmatic, social, and societal behaviors. This laid the foundation for a new, complex approach that studies not only the physical and spiritual aspects but proposes a coherent framework for addressing all these behavioral responses. This is why it is an emerging discipline. While most participants in our congresses come from the humanities, the aim is to incorporate scientific evidence from materials science and other fields. It is a holistic picture.

Your journey began with ethno-archaeology. What first drew you to focus specifically on salt springs?

It was a very personal discovery. In the 1980s, an English and Romanian ethno-archaeologist named John Andrish had an idea: where there are sheepfolds today, there must also have been seasonal human settlements in prehistory. I was impressed, but I noticed on our journeys that the sheepfolds were consistently located next to salty springs. I thought, "This is the key element." The springs attract animals, and where there is a concentration of animals, people also come—to hunt or to raise them. Domestic animals, as is well known, require salt. I began systematic research and in 1992, published my first article on salt water springs in Moldova. This was the genesis of everything.

Your fieldwork uncovered specific historical practices for obtaining salt. What can you tell us about the process and its significance?

We documented the obtaining of recrystallised salt, which in Romanian is called pușcă. There are two main strategies. The first, less common, involves going to a spring with a large metal cauldron, boiling the brine there for a day, and taking the crystallised salt home. The second, easier method was to transport large quantities of brine in barrels back home to process there. Why did they do this? For their own use, for therapeutic purposes, and crucially, for trade. During severe droughts in mountainous areas where cereal agriculture was impossible, people would travel up to 300 kilometers to exchange this salt for grain. It was an essential economic and survival tool.

Beyond its economic role, what spiritual or cultural significance did you uncover?

Salt most often has positive connotations. There is a custom, which also exists in Sicily, of placing rock salt at the base of a window in a room with a newborn. Why? To keep the devil away, because the devil does not like salt. As an American colleague told me when I presented this at UCLA, he smiled and said, "Yes, the devil likes sweets." We also documented various systems for protecting the purity of the springs, from hollowed tree trunks (buduroi)—a system dating back to the Neolithic and still used in India today—to wooden beam structures and small protective houses of Saxon origin in Transylvania. These practices show a deep cultural reverence for the source itself.

Your collaboration with designer Gaia D'Arrigo bridges your academic research with contemporary design. What is the value of translating this ethno-archaeological knowledge into a sensory, artistic installation?

The value is in making the invisible visible again. My research shows that salt was never just a commodity; it was the center of a process that connected people to the landscape, to their health, and to each other through trade and ritual. The modern industrial process severs that connection, hiding the journey and the labour. Gaia's work, in reconstructing the vessels (tage) and representing salt in its three states, re-centers that narrative. It asks the audience to physically experience what it means to interact with this material—to inhale it, to see it crystallize—and in doing so, it rebuilds the lost connection between the body, the material, and its source. It is a powerful, necessary translation.

3.3.1

Le Sere

Residues in twilight

Benedetta Pompili

Le Sere is a series of benches and side tables made from industrial byproducts gathered across Romania. Stained, broken, or uneven offcuts of marble, limestone, and andesite from Baia Mare are joined by steel rivets and topped with handmade ceramic tiles. The tiles are glazed using dust collected from the CupruMin copper mine near Abrud and from wire production at BergBanat in Timișoara.

The glaze—historically both a surface treatment and a form of containment—becomes a method of material disclosure. In the kiln, chemical residues react with heat to reveal the hidden compositions of the sites they came from. The iron can easily mute the copper. Growing amounts of zinc can show through a perfect gloss, or in dramatic crystals or even crawlings. Each tile becomes a kind of map—one that records the tensions between standardisation, opacity and contamination in the chemical industry.

Le Sere—meaning 'the evenings' in Italian—offers a gesture of care toward materials near the end of their lives. Through design, industrial residue is amplified rather than concealed, making visible the complex and essential interdependencies that define the chemical sector.

PARTNERS CMC Baia Mare SRL, CupruMin SA, Berg Banat SRL

BIO

Benedetta Pompili is an Italian social designer based in Amsterdam. Her practice focuses on material research and site-specific production, often exploring how surfaces can be crafted to reflect political, social, and geological histories. She is a technical specialist in ceramics at the Gerrit Rietveld Academie.

3.3.2

The Alchemy of Residue

An Interview with Benedetta Pompili

Le Sere (The Evenings) sees material designer Benedetta Pompili explore the latent potential of Romania's industrial landscape. Working with byproducts from copper mining, stone cutting, and steel galvanisation, Pompili assembles a family of side tables and benches that serve as deep material portraits of place. In this interview, she speaks about her process of crafting a revelatory glaze from industrial dust—a material alchemy that acts as a chemical "pH strip" to uncover the hidden compositions and unresolved consequences of the region's chemical industry. She reveals how her work, which incorporates collaboratively woven copper baskets from local Roma artisans, is a practice of care-taking, transforming toxic residues and fragmented knowledge into objects of resilience, beauty, and traceable narratives.

Your practice is deeply rooted in the properties and politics of materials, especially clays and glazes. How did this approach first emerge for you?

BENEDETTA POMPILI
It began during my time at the Design Academy Eindhoven. I had a background in ceramics, but it was a collaboration with a ceramicist who was also an archaeologist that changed my perspective. He taught me to see the material not just on a macro level, but to go down to its microstructure. For my graduation project, I combined this technical knowledge with an architectural situation, specifically the issue of asbestos. I wasn't interested in endangering myself, but in understanding the mining consequences of making. What fascinates me about ceramics is the direct contact with raw, unprocessed materials. You acquire these raw ingredients and craft a body or a surface, which immediately brings you to their sources and the processes they've undergone. This led me to collaborate with a company that treats asbestos cement, using their byproduct to lower the amount of virgin clay I needed, thereby reducing the amount of mined material.

You've worked with wild clays, residuals, ashes, and industrial waste. What have you learned about toxicity, craft, and care through that work?

I've learned that working with secondary materials is a way to dive deep into the process itself. Purity makes things easy for industry, but reality is different. These materials come with so many unexpected elements and impurities; they force you to understand the entire chain. In Japan, I worked with hama, the single-use porcelain dishes used to prevent cracking during firing. That project was about working within a large-scale production system and proposing a redesign where the waste element could be reused as part of the final object. It was a precise, communal way of thinking about waste. But the amounts we work with in ceramics are small—a few hundred kilos a year. We can't solve the landfill problem, but we can propose new narratives and applications that industries might adopt.

CMC Baia Mare factory area, courtesy of Benedetta Pompili.

Your project CHIMICA for Bright Cityscapes is assembled from industrial byproducts across Romania. What are these materials and what stories do they tell?

The selection was a collaboration with the FABER team, based on availability and their chemical content, which ties back to the theme of Romania's chemical industry. We worked with several key partners:

— Vinmar: A governmental company that provided an earthy material containing 20% copper, a crucial element for both Romania's industrial history and a traditional component in ceramics.

— A galvanisation factory: They provided waste byproducts from steel galvanisation baths, rich in iron oxide and zinc oxide—again, classic ceramic materials that the factory considers an issue.

— CMC Bio: Stonecutters who generate a mud waste from cutting local marble and granite. This silica-rich material is a perfect base for glazes and exists in massive quantities, piled meters deep in their factory.

Slurry coming from the cutting of stones at CMC Baia Mare, courtesy of Benedetta Pompili.

The fascinating part is that these materials come from precision industrial processes and are already in a perfect, dust-like form for immediate reuse. I don't need to invest extra energy, water, or electricity to process them; I can recoup and test them right away.

The glaze in CHIMICA plays a crucial symbolic role, not just a technical one. How does it work, and what does it reveal?

The glaze is the protagonist. It's what brings every industry I'm collaborating with together. These companies are often reluctant to share the precise chemical analysis of their byproducts; they protect their knowledge, their secrets. But the kiln doesn't lie. My role is to use my knowledge to act almost like a pH strip or a camera. I put these blended materials into the kiln, and the firing process reveals what is there. For example, zinc from the galvanisation process will hyper-saturate blues if copper is present. These chemical relationships thrive with each other and show each other. The glaze doesn't cover; it reveals the truth of the material—its composition, its history, its hidden value. It makes the invisible, visible.

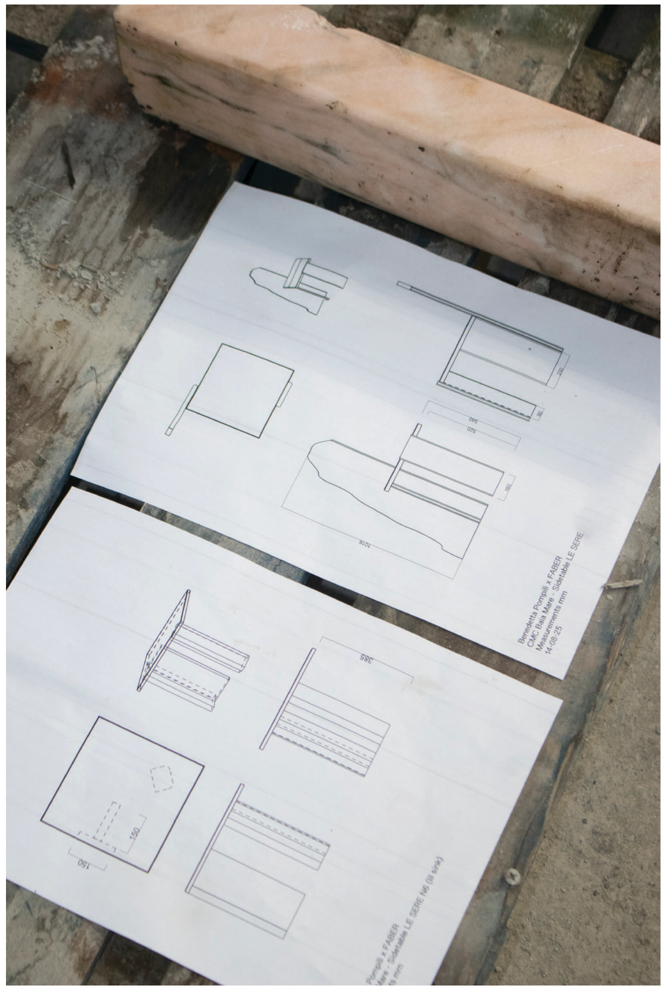
This resonates strongly with Norbert Petrovici's research for this exhibition, which identifies "residual knowledge" and fragmented innovation as a key blockage in Romania's chemical sector. Do you see your work relating to this?

Absolutely. The closedness, the lack of shared knowledge—I experience it directly when I can't get analyses from the companies. But the materials carry that knowledge chemically. When I take a piece out of the kiln, it's like archaeology. I find myself with an object and I start to deduce: Why does it look like this? What process did it go through? These inorganic traces are invaluable. If you can read them, it's a form of knowledge that can be shared and grown by others; it's not completely idiosyncratic. My work is about tapping into that residual knowledge stored in the material itself and creating a common process for understanding it.

How do you regard waste and byproducts more generally in your practice? What is design's role in relating to it?

My reasons are multifaceted—political, cultural, and financial. Sourcing secondary materials is often free, which allows me more freedom to research. But more deeply, I find it a way to enter processes and understand what remains of them. For me, 'waste' is the wrong term; I prefer 'secondary material' because it implies it still holds economic, creative, and cultural value. I've chosen to work at the end of the industrial line instead of the beginning to better understand the process and bring my part into it.

I don't see myself as a designer who streamlines production for efficiency and purity—that assumes the public always wants the same outcome. I am happier in this role: discovering, changing opinions about these materials, and showing their beauty and the narratives they carry. They have a more human part to them. I think our role is to be more human in the way we look at objects and the systems that produce them.



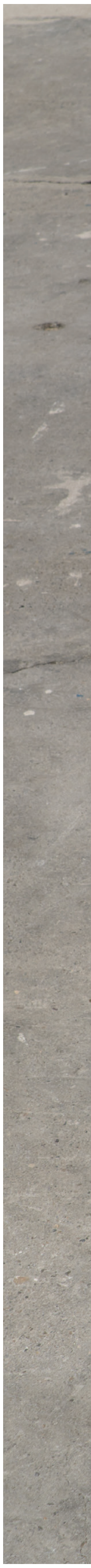
Technical drawings in the making, courtesy of Benedetta Pompili.

3.3

Hot Dipped

The Frog and the Sacrificial Skin

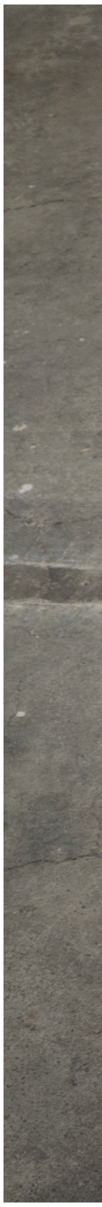
Audrey Large



Hot Dipped: The Frog and the Sacrificial Skin is a material investigation into galvanic protection, where one metal sacrificially corrodes to save another. Designer Audrey Large's project combines hand-sculpted steel sheets, subjected to industrial hot-dip galvanisation in molten zinc, with sculpted in Virtual Reality and 3D printed steel connectors.

The project takes the form of a desk: a heavy steel plate balanced on two slender trestles made of hand-knotted steel wire. Each trestle is composed of three distinct parts, held together by a tiny, organically shaped 3D-printed connector in the centre. These tiny, untreated components lock the trestles together and support the weight of the desk, making the entire structure dependent on vulnerable parts that slowly succumb to corrosion, thus turning the technical process of protection into a narrative of vulnerability.

Echoing Luigi Galvani's experiments with "animal electricity," the work reimagines galvanisation as both a chemical and philosophical gesture. The frog in Galvani's experiment is an organic conductor, while the 3D printed parts in Hot Dipped act as the frogs in the desk structure. The project explores the shift from vitalist theories to mechanistic thought, framing industrial protection as a sacrificial, almost vital, act where value and vulnerability are perpetually negotiated.



BIO

Audrey Large is a French artist and designer based in the Netherlands. Her work explores digital cinema and image manipulation, using 3D printing to challenge how we perceive matter. A winner of the Dezeen Emerging Designer award, her work is exhibited internationally and held in the collection of the Stedelijk Museum Amsterdam.

TECHNICAL PARTNERSHIP Berg Banat SRL, Nutechnologies SRL

3.3.2

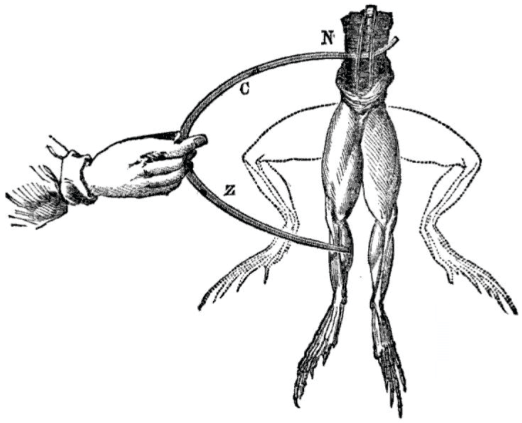
Of Frogs' Legs and Sacrifice

An Interview with Audrey Large

Audrey Large's practice interrogates the materiality of the digital image, transforming fluid digital simulations into tangible, impossibly smooth 3D-printed objects. For Hot Dipped: The Frog and the Sacrificial Skin, she turns her critical eye to the chemical substrates of digital fabrication itself, engaging with the industrial process of hot-dip galvanisation. In this conversation, she discusses how a 19th-century search for the "life spark" within matter informs her approach to technology, protection, and the latent vitality hidden within industrial and digital workflows.

Audrey, your work is often described as an inquiry into digital imagery and its materialisation. For this project, did your focus shift towards the actual chemical processes that make this materialisation possible?

AUDREY LARGE
I have always been interested in the perception of digital matter and the materiality of images, for example the first photographs were imprints of light on light-sensitive chemicals and on metal or paper supports. The history of image fabrication is based on chemical transformation. Images always have a materiality, including digital images, and I like to explore this in my process of translating images into objects. For example, when I use SLA 3D-printing, I like the idea that within the making process itself, digital files harden through UV Light into tangible objects, which in turn become light bulbs diffusing light in a lamp.



By Luigi Galvani. Source: David Ames Welles, The science of common things: a familiar explanation of the first principles of physical science. For schools, families, and young students. Publisher Ivison, Phinney, Blakeman, 1859, 323 pages (page 290), Public Domain, https://commons.wikimedia.org/w/index.php?curid=36497119

You chose to work with a galvanising company, a significant shift from your usual studio practice. What drew you to this specific industrial process?

I was invited by Martina [Muzi], and from the beginning, I knew the theme was the chemical industry. She did onsite research in Romania, identifying different factories and companies, and proposed several to me. I chose a galvanising company. Initially, I wasn't very familiar with this way of working. I usually work digitally in my studio—it's a crafty, hybrid, digital way.

So, outsourcing a very material process to another country was a new challenge. I started by looking into the history of galvanisation.

I found it fascinating that this process originated from the experiments of Luigi Galvani, an Italian scientist searching for the "life spark" or "animal electricity." He experimented with frog legs and different metals, discovering that applying two different metals made the leg contract. For him, this was proof of a vital life force. This was during a time of strong vitalist theories. So, this chemical process emerged from a quest to prove the vital force in matter. That same process was later industrialised, leading to the invention of the battery by Volta and ultimately contributing to our mechanistic, industrial world.

I found it compelling that the history of this chemical process encapsulates the entire transformation from a vitalist to a mechanistic worldview. My approach became: I'm working with an industrial factory that produces industrial parts. How can I reuse this technique to reintroduce a vitalist spark into the object? My answer was to do this by introducing the hand and the digital. I drew parallels between mysticism and digital theory in matter, and thinkers like Erik Davis who analyse the digital world.

That's interesting because your previous work seems to live very much in the digital world. You speak about how something esoteric becomes an industrialised chemical process. Do you see parallels between the chemical industry—akin to alchemists turning lead to gold—and the way the digital world channels esoteric ideas into something physical?

Yes. Both digital infrastructure and technologies are products of mechanistic thinking, and they also produce a mechanistic world. But in between, they imbue our material life and our thinking with a kind of mysticism, a spirituality. There's an aura to it, something we cannot grasp that feels alive. In my work, I try to use the digital not in a standardised, mechanistic way, but to inject a lot of sensitivity and a human touch. When I craft a file, when I sculpt in 3D, I try to imbue the forms with sensitivity and aliveness. It's a way of counteracting the machine. The shapes aren't computer-generated; they are hand-generated but enabled by the computer.

Looking at the history of galvanisation, what I found interesting is that it wasn't invented industrially. It came from a moment of shift when the inventor was still thinking within vitalist theories. So, this industrial process contains a seed of vitalist thinking that later turned mechanistic. Moreover, hot-dip galvanising involves dipping steel into a molten bath of zinc. It's not just a coating process; there's a bonding that transforms the structure of the steel, creating an alloy and changing the metal's properties. On a chemical, microscopic level, there is a binding, an interrelation, a metamorphosis of the material itself.

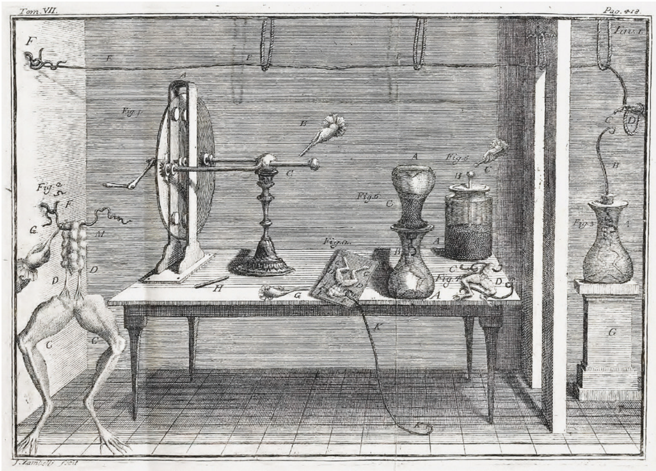
The concept of "sacrificial protection" is central to galvanisation, where the zinc layer corrodes to save the steel. How does this metaphor resonate with your view of the digital age?

It's a story of transformation and protection, not destruction. The zinc sacrifices itself through a porous, active process. In our digital world, we build infrastructures of connection—like the first galvanised telegraph cables—that contain both protection and a hidden cost. I try to protect the "life spark" in my work by imbuing digital shapes with sensitivity and an imperfect gesture, creating a moment where a dialogue between the human and the material can happen.

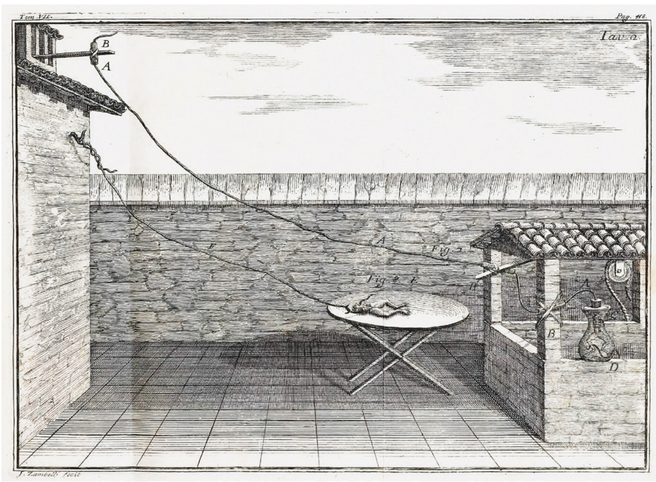
You can see this when we look at a microscopic image of a galvanised metal part. You see a zinc layer on top, a steel layer inside, and in between, an alloy where the materials bond. The zinc acts as a protective layer against corrosion; it corrodes preferentially to protect the steel. It sacrifices itself.

So you're almost talking about zinc as a living entity. You cite people like Erik Davis, who talks about an energetic field of consciousness, and Galvani, who saw a life spark. Do you think this personified humanness is inherently there in technology and chemical processes, or is it something we project onto them to understand them?

I wouldn't say it's animistic or about projecting humanness. Vitalist theory isn't about animism. I



By Luigi Galvani — De viribus electricitatis in motu musculari commentarius, Tav. 1, Public Domain, https://commons.wikimedia.org/w/index.php?curid=2809107



By Luigi Galvani — De Viribus Electricitatis in Motu Musculari Commentarius, Tav. 2, Public Domain, https://commons.wikimedia.org/w/index.php?curid=55077832

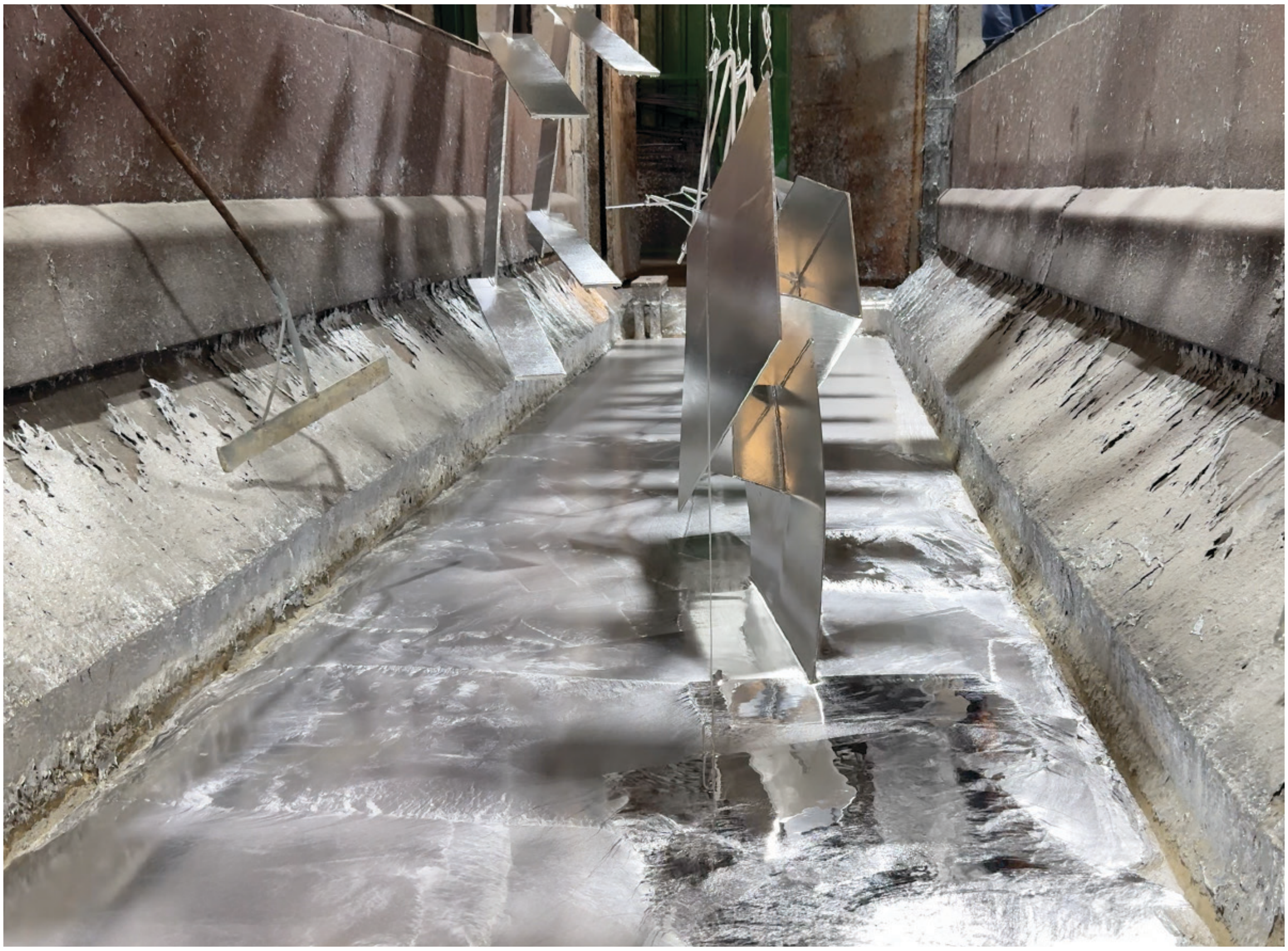
reference Jane Bennett's "vibrant matter" because she looks at the vitalist life spark not only in animals and humans but in all matter—even rocks. Our industrial world and the scientific revolution removed this vitalist layer. I think about the aliveness of things as a special strength or power inherent in all matter, which has its own energetic field. My intention is to bring back this life spark into objects through the digital.
Galvani was trying to reanimate dead bodies; his experiments led to stories like Frankenstein. There was a moment when society believed there was much more aliveness in things, before the industrial world stripped that away. The idea is to turn it around—to reintroduce a narrative of sacrificial protection, alloy bonding, and material interrelation into the shape of an object.

In your text, you use this to ask a question about now: what remains to be protected? What are we sacrificing in our digital age for the sake of connectivity and progress?

I'm also a user of these technologies—I use them in my practice but also in my personal life. It's not about rejecting them. But when I create, I try to channel as much sensitivity as possible into the material and the form. I try to protect the life spark, the sensitivity, the imperfect gesture. In that shaky, imperfect moment, there can be a dialogue between the human and the material. I try to find and expand that moment.
Galvanisation embodies this idea of protection—it's an anodic and cathodic reaction where one layer sacrifices itself to protect the other. It's not an enclosed protection; it's porous, active.

It's interesting because galvanisation protected the underwater telegraph cables that formed the earliest global network—the foundation of the internet. How does layering this material history onto our digital present change our understanding of technology?

It's a story of how a process and a material bonding can lead to both interconnection and destruction. New technologies always contain both. The development of the global network and underwater cables brought hidden structures and materialisation, enabling even more mysticism around digital technology.



The telegraph, for example, introduced the idea of transmitting information immaterially, which led to stories of energy and magical transmission. It gave people an imaginary, a layer of magic on top of digital technology. Galvanisation occupies a very interesting position in that sense.

Vitalism is now often seen as a debunked theory, a pseudoscience like alchemy, yet Galvani's work was incredibly influential. How can these supposedly obsolete ideas influence us in the digital age?

I sometimes feel our way of thinking is not grounded enough in spirituality. Vitalist theories may have faded in relevance, but for me it's a fascination around this kind of thinking as opposed to the mechanistic thinking that followed it, rather than going back to this exact ideology from a past century and rejecting computers or mechanistic things.

It is also interesting to try and use these theories not at the usual scale of my workshop production, but to infiltrate a factory that produces on a large scale and is attached to a real industry.

This project seems to strip away the layer that separates the chemical, industrial, mechanical world from the organic world.

Everything is chemical. Everything is a transformation of matter. The galvanising process is amazing—it involves high temperatures, dipping one metal into another molten metal, changing its structure, creating an alloy with new properties. Electrons are moving and changing. There's an alchemical layer to it.

You've spoken about destruction as a neutral force, not necessarily bad. In Eastern spirituality, destruction and creation are part of a cycle, neither good nor bad. Is that something you're exploring?

Definitely. I try to remove boundaries and dichotomies in my thinking. For me, everything is in transition or cycle. In the chemical process, I don't see destruction. I see two materials meeting, bonding, alloying, and one dissolving through porosity to protect the other. It's a story of transformation, protection, and porosity. Dissolving or corroding is a protective process—it's positive. There's no split.

Your work always has a liquid, alive quality. Even before this project, you seemed interested in animating the digital, charging it with a sort of animal electricity. How does this project expand those ideas?

Usually, my work is very liquid. I work a lot with perception—using surfaces and materials that interact with light, so the object changes as you move around it. I try to create a moment where you don't know what you're looking at—whether it's heavy, real, or not.
For this process, it's different because there are many uncontrolled factors : the inclination of the piece when dipping, the type of steel employed, all can affect the outcome.

Usually, my materialisation step is very controlled; I want the object to look exactly like my file. Here, I have to make something in metal first, and then the galvanising process decides the surface. There's randomness.

This project tells a story of protection and sacrifice between zinc and steel. I am collaborating with two companies based in Timișoara: a hot-dip galvanising factory and a 3D-printing facility capable of producing steel parts. Drawing inspiration from the etchings of Galvani's experiments and the iconic image of the frog leg (an organic, liquid-like form acting as an electrolyte between two charged metal parts activated by touch) I am developing a piece whose structure translates the interrelation of metal and the organic. The project takes shape as a balanced object in which delicate 3D-printed steel elements structurally hold galvanised heavy metal sheets. The printed steel acts as the living, essential "frog," and the galvanised elements as the sacrificial skin that protects and completes the circuit of vitality between them.

Images from the galvanisation bath inside the factory, showing the steel structure of the desk created by Audrey Large.

3.4

Uncommon Material

Plastic Futures in Decay

Andreea Tron

Uncommon Material explores how compostable bioplastics—typically designed to disappear—can be reimagined into lasting, functional surfaces. The project emerged from a direct collaboration with Promateris, a Romanian manufacturer of starch-based compostable bags and films. Within their production loop, offcuts and rejected batches are recycled into new granules. Some materials, however, are unmarketable due to colour variation, texture, or a strong corn scent.

Rather than concealing these qualities, designer Andreea Tron highlights them. With the factory as a starting point and the source of the material and the investigation, she developed together with two universities, three surface typologies: a compact ”tapestry”, a translucent curtain, and a lightweight pergola assembled through crochet inspired 3D prints and interlacing.

What might it mean to design with a material not meant to last forever? Uncommon Material challenges the expectations we place on plastics—uniformity, longevity, neutrality—and suggests a new vocabulary rooted in circularity, sensory richness, and site-specific reuse.

BIODEGRADABLE RECLAIMED GRANULES AND RECYCLED FILM Promateris SA
RESEARCH SUPPORT Andreea Sachelaru (R&D Manager, Promateris)
DEVELOPMENT OF 3D PRINTING FILAMENT FROM GRANULES Prof. Dr. Eng. Cătălin Zaharia; Lecturer Eng. Ionuț Cristian Radu, Faculty of Chemical Engineering and Biotechnologies, National University of Science and Technology POLITEHNICA Bucharest
3D PRINTING Vlad Rebenciuc, Atelier Vast
SHEET PRESSING Irina Antohe & Teodora Munteanu, Plastic Afterlife / Nod Makerspace
RESEARCH AND INJECTION MOLDING PRODUCTION Prof. Dr. Christian Rytka; Research Assistant Mariona Diaz Rodenas, FHNW University of Applied Sciences and Arts Northwestern Switzerland, Institute of Polymer Engineering, Brugg, Tudor Munteanu, Sandra Berghianu

BIO

Andreea Tron is a Romanian designer based in Switzerland, working at the intersection of craft, technology, and regenerative design. With a background in architecture and textiles, her practice explores biomaterials and circular systems through hands-on making.

3.4.2

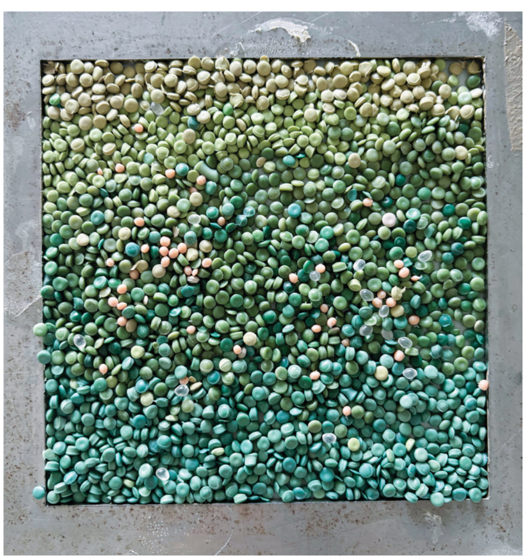
The beauty that lies dormant in the uncommon

An Interview with Andreea Tron

Uncommon Material: Plastic Futures in Decay is a design investigation that challenges the perceived limitations of industrial surplus. The project centers on a specific starch-based granulate—a compostable biomaterial used by the Romanian producer Promateris for shopping bags and films. During production, offcuts and quality-control rejects are reprocessed, but some batches, marked by uncommon colours and a distinct starch scent, are deemed unsuitable for the market.

Designer Andreea Tron brought her signature blend of craft, technology, and regenerative design to the project, in collaboration with Promateris R&D Lead Andreea Șachelaru. She explores these very qualities as a starting point for new aesthetic and functional possibilities. Through a process that bridges handcraft, industrial thermoforming, and exploratory 3D printing, the project translates this "waste" material into a series of surfaces—a tile-like floor, a laced pergola, and a translucent curtain—asking us to reconsider beauty, utility, and the very lifespan of the materials we use.

Andreea Tron, the concept of Uncommon Material is about finding beauty and utility in industrial surplus. What was the pivotal moment that sparked your connection with Promateris and led to this collaboration?



ANDREEA TRON
I first visited the factory with the FABER team, and we met with the CEO and with Andreea. Through our conversations, we discovered they had this surplus material, which is both recycled and biodegradable. For me as a designer, this sparked immediate interest, of course, precisely because it's also a difficult material to work with. Its recycled nature means the properties are not as consistent as virgin material. But that difficulty was the attraction. That was the starting point.

Andreea Șachelaru, from your side at Promateris, how did you feel when first approached about a collaboration that would take your work from an industrial setting into the realms of art and academia?

ANDREEA ȘACHELARU
I was really happy to hear the proposal. I think it's really needed to collaborate with other fields and to find new applications for a material that you'd think doesn't have any application anymore, or has only a single one. To be honest, I thought it was very ambitious. Our recycled material comes from bags and films, and in theory, it would be very hard to transform it into something else unless you modify it chemically. So I thought, "Wow, that's really ambitious, but let's give it a try." I was happy they were willing to work with it, but also a little suspicious that it might not work.

Andreea Tron, what was the biggest challenge or surprise in working with these distinct circular materials compared to more conventional ones?

AT I'm used to working with unconventional materials and leftovers, but I had never worked with real industrial surplus. This was completely new. I also hadn't worked with bioplastic granules before. The most interesting part was receiving this raw material with ambitious but naive plans. I thought, "I want to make filament for 3D printing, I want to make tiles, maybe do some handcraft." It was the process of finding the right people to help me—connecting with specialists who could actually make this happen—that was so revealing. The material was challenging, and I was naive about it, but I think that helped. For me as a designer, it's very important to have challenges. This project was a lot about making impossible things happen.

To what extent was the final work a fulfillment of those ambitious plans, and to what extent did you have to compromise?

AT To be fair, I didn't compromise so much on the vision, but a bit on the final designs. The development phase—transforming the material—took longer and was more challenging than expected. But I did manage to create a 3D printing filament and print with it, which was a significant challenge. The results are still a work in progress, open to further development. I also made tiles. What's missing now is the technical testing to see how they could be used functionally. For now, they are beautiful surfaces that demonstrate a transformation, but the next step would be to validate their functionality.

Andreea Șachelaru, how could this work influence Promateris's approach, not just environmentally, but in terms of seeing new potential for your products?

AȘ It came as a really nice, fresh perspective. We are very focused on shopping bags and films, so we haven't looked a lot into different applications, which would require investment in R&D and new equipment. This feels like a beginning point to put more attention on what else we can do with what we have. I would be very happy to continue, to test the materials with our possibilities and see where we can go technically. It's something needed for us to grow as a company, but also from a sustainable point of view, to put more applications to the product.

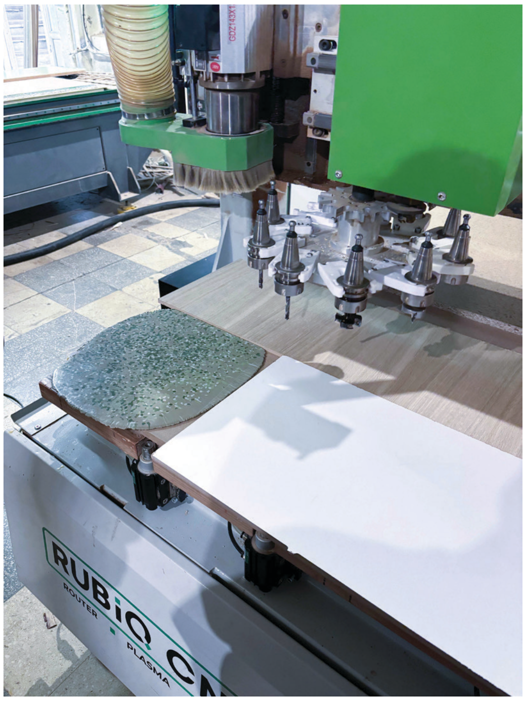
Andreea Tron, the project employs a fascinating range of techniques, from traditional crochet to industrial thermoforming and high-tech 3D printing. Why did you choose to test the material across such a broad spectrum?

AT It was a long process of thinking about what to do with a material that is a replacement for plastic but is designed to biodegrade. How do you design an object that isn't meant to last forever? My idea was to test it in three different ways to see its potential: handcraft, which is my base as a designer; established industrial processes like thermoforming; and more experimental, technological processes like 3D printing. It was a big exploration. Now we can see where the most potential lies for a functional application.

A key part of the installation is the sensory experience—the smell of starch, the softness of the 3D-printed objects. How important was it to engage with these material qualities that are often seen as flaws?

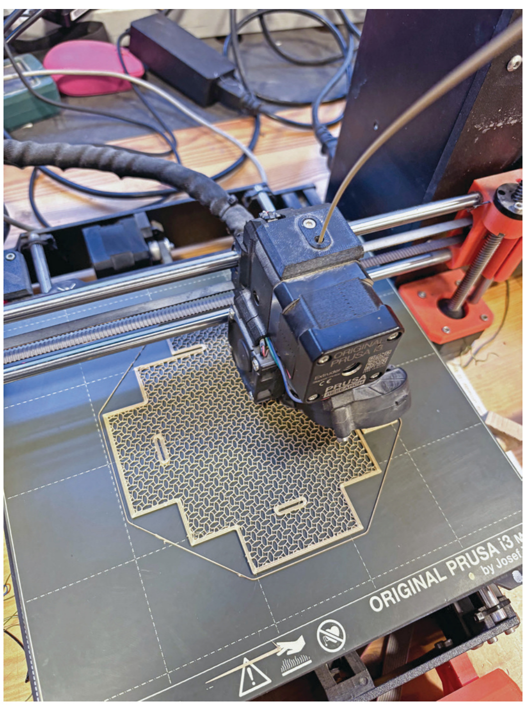
AT For me, these qualities are beautiful. The smell is a popcorn-like starch scent. When you heat the material, it comes out. I understand clients might be bothered, but I think we need to change this perspective; natural materials have their own smell. In terms of touch, the material is amazing—super soft and flexible. The 3D-printed objects resemble textiles, which was my goal, and the tiles are warm, unlike traditional plastics. I wanted to highlight these qualities, to express the potential of this material beyond its commercial constraints.

Finally, looking to the future, to what extent do you see this work expanding into the real world? Andreea Tron, do you think there will be a time when clients are no longer freaked out by bioplastics?



AT From my perspective, a personal challenge was to take this material out of the plastic universe—to not see it just as a replacement. But all the processes I used, like injection molding and 3D printing, are based on a plastic infrastructure. I didn't manage to find a way to use it completely outside of that. I think that's a bigger project, about what new infrastructure is needed. My role is to show the potential, to make people visiting an exhibition wonder, "Oh, this is a possibility." We need to work on it, but the material is there.

AȘ I definitely think bioplastics are a viable alternative for many applications. The battle is often with policymakers to see the potential on a bigger scale. It's difficult to invest without a larger push. But it makes sense in many fields, like agriculture or gardening, where you need biodegradable alternatives that don't leave toxic residues or microplastics. The tiles, for example, could be an opportunity there, replacing plastic options. It's very interesting to continue exploring this, combined with design creativity and a shift in perspective.



Zoom In

Green Transition and local realities in the chemical industry

Marian Ignat
Patricia Cîrtog
Susanna Tomassini

Zoom In: Green Transition and Local Realities in the Chemical Industry offers a journalistic inquiry into the complex landscape of environmental transformation in Romania's chemical industry, developed by journalists Patricia Cîrtog and Marian Ignat with the visual designer Susanna Tomassini. The project presents three video essays that merge investigative text with visual narratives, using found footage, archival material, and original photography to dissect the tensions between policy, industry, and ecology.

Each case study examines a pivotal chemical actor: Brenntag, a distributor navigating the gap between EU sustainability goals and local market realities; CupruMin, a state-owned mine whose expansion highlights the environmental cost of strategic raw material extraction; and Chimcomplex, a petrochemical giant balancing their need to remain competitive in an age of modernization with their responsibility to radically reduce emissions.

These visual essays move beyond simple reportage to question the very materiality of transition—documenting the infrastructural delays, economic pressures, and regulatory ambiguities that define the pace of industrial change. The work exposes the contested ground where global climate ambitions and the deepening need for climate justice meets local chemical realities.

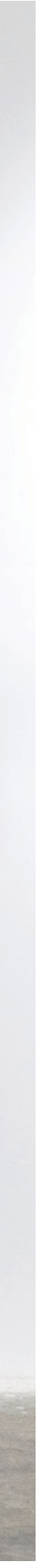
BIOS

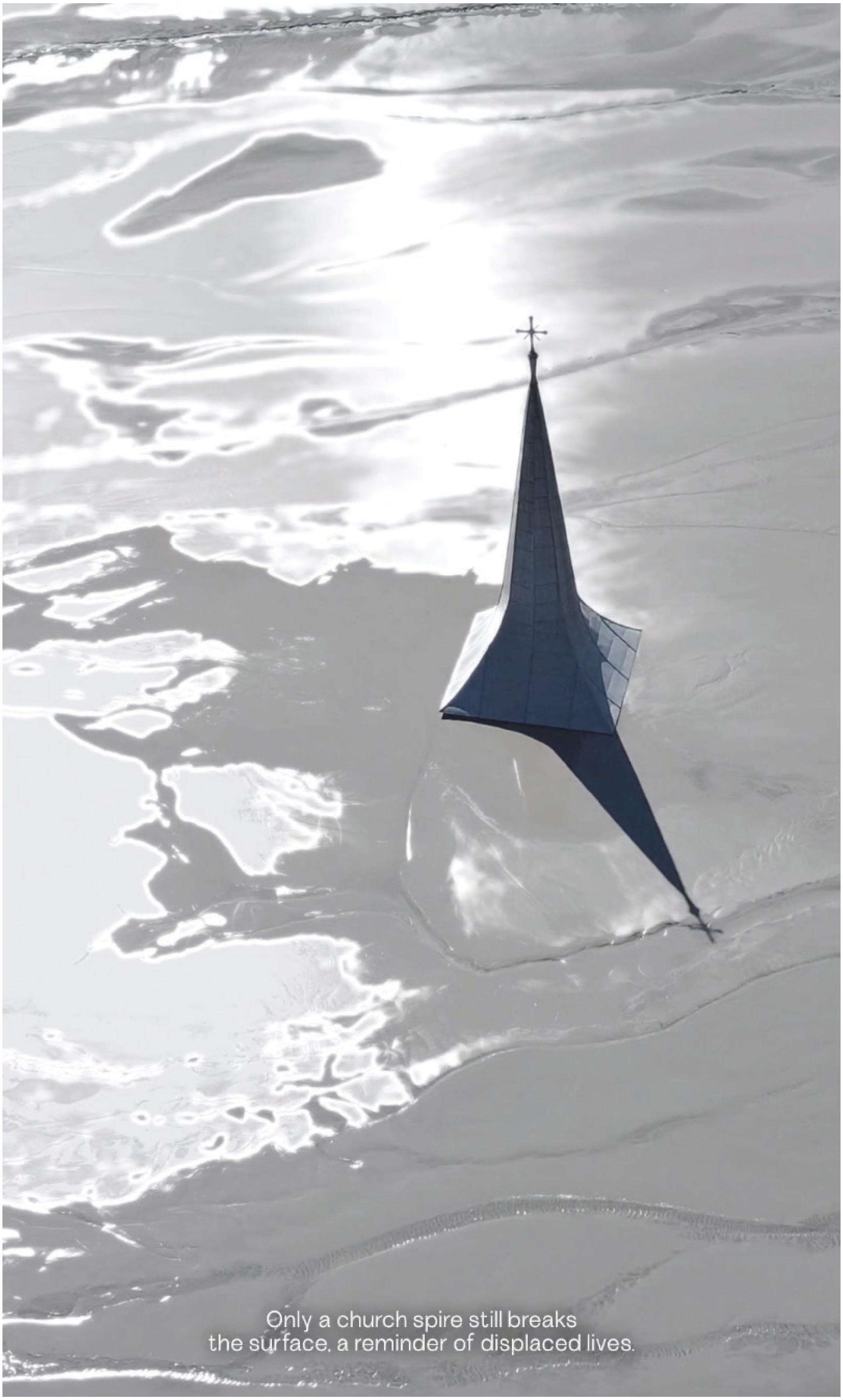
Marian Ignat is a freelance journalist focused on the climate crisis and the green just transition. He has written for Libertatea, Scena9, and Mindcraft Stories, and co-hosts the noua grijă newsletter. He is currently pursuing a Master's in Public Policy with a specialisation in energy, environment and sustainability at Sciences Po Paris.

Patricia Cîrtog is a journalist who collaborates with Scena9 and Libertatea. She is the co-author of the noua grijă newsletter, addressing the climate crisis through a hope-based lens. She is currently pursuing a Master's degree in Health Psychology in Cluj-Napoca.

Susanna Tomassini is an Italian visual designer based in the Netherlands. Her multidisciplinary practice seeks new narratives around social and political topics, deconstructing mundane subjects by merging digital and printed media, and increasingly, video.mie.

VOICEOVER Christine Cizmaș
WITH CONTRIBUTION BY Raluca Pintea
(HSE Manager, Brenntag România)




Only a church spire still breaks
the surface, a reminder of displaced lives.

3.6

Zoom In

Visual Essay

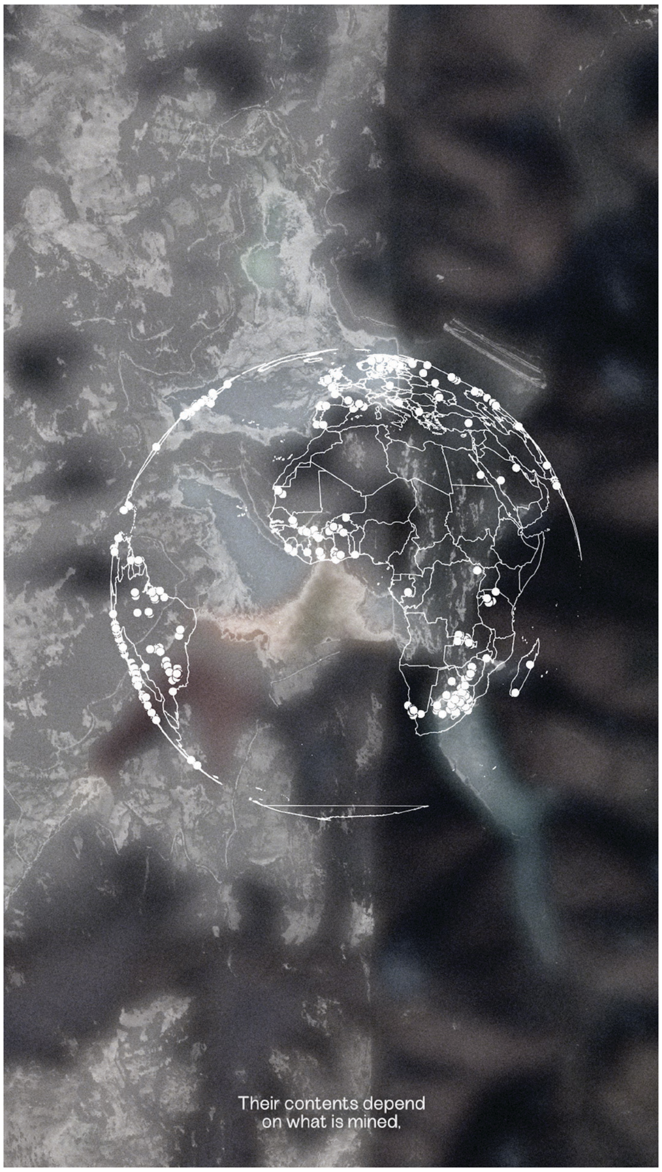
Marian Ignat
Patricia Cîrtog
Susanna Tomassini

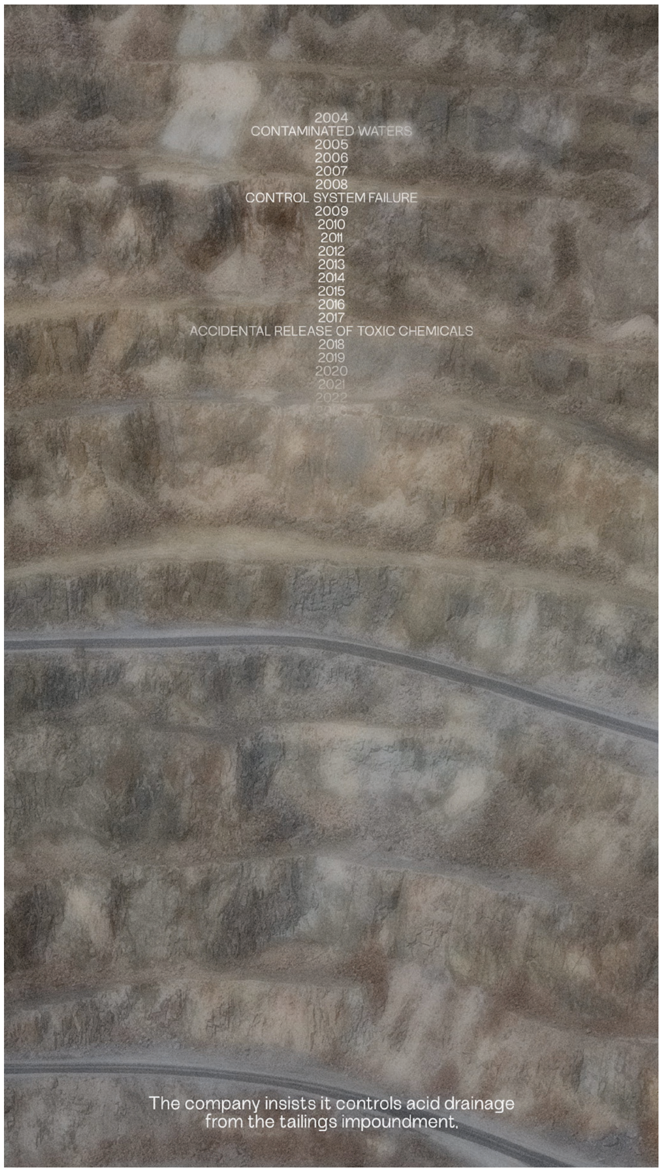
Photo: Provided by Alex Todirică

Photo: Provided by Alex Todirică
Data: Provided by Marian Ignat, Patricia Cîrtog (https://shorturl.at/of6gX)

BRENNTAG SA

Brenntag sits at the crossroads of Europe's green ambitions and local hurdles. It is a chemical distribution company with 25 years of experience in Romania and over 150 years of existence. The European Union's Green Deal has set environmental targets for the chemical industry, one of the biggest polluters worldwide. But Romania's price-driven market, weak infrastructure, and patchy enforcement of regulations slow down progress. At its Chiajna site near Bucharest, Brenntag pushes sustainability through returnable packaging, carbon-tracking tools, and community projects. Yet, convincing clients to pay more for greener products remains a major challenge. Broader systemic issues – outdated railways, "lowest price" public procurement, and limited state incentives – make decarbonisation even harder. EU funds could help, but their impact depends on how Romania uses them. A new EU plan launched in 2025 aims to rescue the struggling chemical sector with cheaper green energy, innovation incentives, and lighter regulations. Brenntag's story highlights the gap between Europe's climate vision and the reality on the ground.





Satellite image: © Google, 2025, Images from © 2025
Maxar Technologies and © 2025 CNES / Airbus
Data from: https://tailing.grida.no/map/data/

Photo: Provided by Alex Todirică

CUPRUMIN SA

Roșia Poieni symbolizes the clash between resource demand and environmental costs. It is Europe's second-largest copper mine, managed by state-owned CupruMin. The open-pit mine in Romania's Apuseni Mountains blasts 14,000 tonnes of rock daily, shipping copper concentrates mainly to China while leaving toxic waste behind. Entire villages like Geamăna were submerged under tailings, and repeated spills have poisoned rivers, killing fish as far as 80 kilometers downstream. Despite evidence of land instability and long-term ecological decline, accidents have brought only token fines. With the EU labeling copper a "strategic raw material" for the green transition, pressure to expand domestic mining grows – but Romania lacks smelting capacity, exporting value while retaining pollution. Roșia Poieni is both a cautionary story and a test of whether mining can ever align with environmental justice.

CHIMCOMPLEX SA

Chimcomplex has resisted regime change and proved its success. Can it hold up during the green transition too?

Built during the communist regime in 'the citadel of Romanian petrochemistry', in Onești, Chimcomplex has survived the transition years and maintained its status as one of the largest chemical plants in Romania up to this day. Hundreds of millions of euros have flown into privatisation, modernisation and expansion, most recently by acquiring Oltchim.

But with market power comes environmental and social responsibility. Chimcomplex's activities are equivalent to one of a medium-sized city in Romania in terms of emissions. Transforming how they power their chemical plant was one of the main measures to bring down emissions and improve efficiency. But the green transition clock is ticking. In a constantly changing political environment, where regulations are followed by simplifications, and the race to net zero increasingly more competitive and hostile, this story reflects the broader challenges of industrial transformation during the climate crisis.

3.7

Air Quality

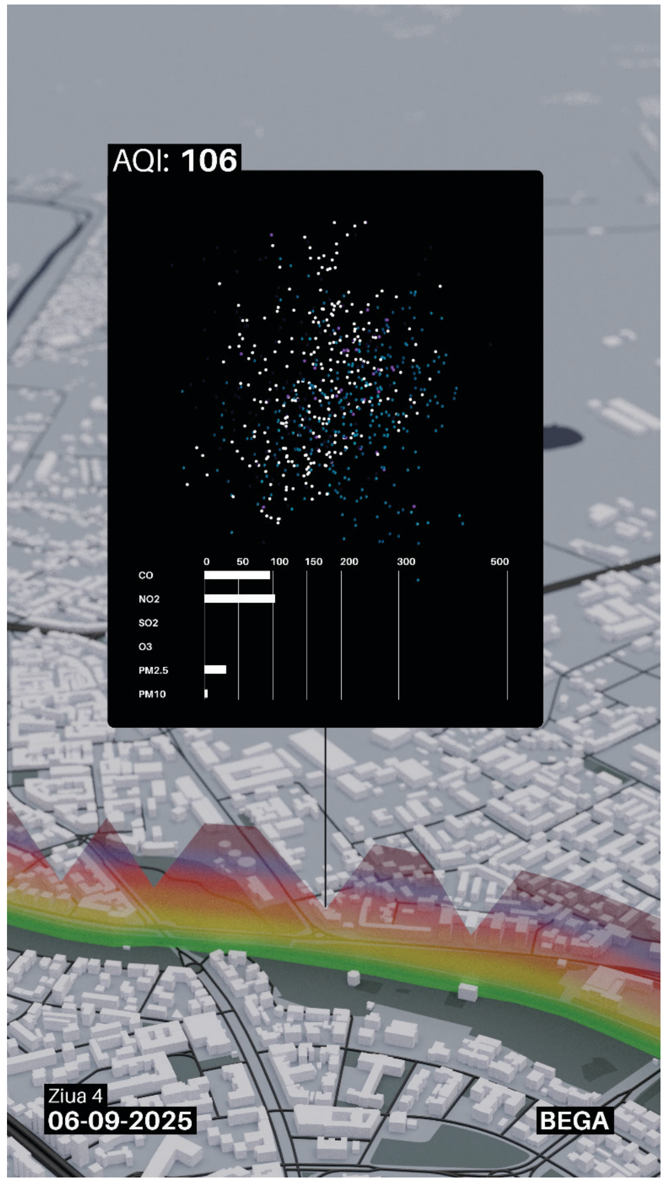
The Sensing Unit

Fabio Salvadori
Federico Santarini
Marian-Emanuel Ionașcu

The Air Quality – Sensing Unit is a monitoring station designed to measure the atmospheric composition over Timişoara from September 26th to November 11th, 2025. Using a high sampling rate, it tracks a comprehensive suite of pollutants—including Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2), Ozone (O3), and Particulate Matter (PM1, PM2.5, PM10).

The collected data is streamed to a connected indoor display terminal, which visualises the real-time environmental conditions for the public. Developed for the Chemical Bonds exhibition at FABER, this project is an outcome of the Young Matters Program. It renders the invisible chemistry of the city's air into a tangible, accessible public record, fostering awareness about the immediate atmospheric environment.

SENSORS AirView
OPERATIONAL ASSISTANTS Adela-Elena Şerbulescu, Ionel Vasile Andras, Vlad Coroban, Răzvan Jebelean, Sebastian-Ionel Petruc



BIOS

Federico Santarini is an information designer and creative coder based in the Netherlands. He specialises in data visualisation and physical computing, creating interactive installations that explore the boundaries between digital information and tangible experience. He holds a degree in Information Design from the Design Academy Eindhoven.

Fabio Salvadori is an Italian visual designer based in the Netherlands. He creates work in music and light installations. His practice is defined by a meticulous care for typography and versatile visual systems, using clear, illustrative narratives to communicate complex information.

Marian-Emanuel Ionașcu is a research assistant at Politehnica University of Timișoara, bridging a decade of automotive industry experience with computer science. His work focuses on developing IoT and wearable devices for real-time air quality monitoring. A contributor to international research grants and academic publications, his mission is to empower communities with actionable environmental data.

Neighbourhood Conversations

4.1

Neighbourhood Conversations

Azur and its People — A Century of Chemistry in Timișoara

For over a century, the Azur factory has been a quiet witness to life in Timișoara. Since 1923, its purpose shifted from producing soaps, detergents and paints to serving global niches, but its deeper function remained constant: it formed a community. The memory of Azur does not reside in its products, but in the people who worked there—they are its true keepers.

Through personal testimony, the Neighbourhood Conversations project seeks to archive this living cultural heritage. What follows are selected excerpts from interviews with those who have shaped, and been shaped by, Azur.

MARC ANDRE FRITSCHE
GENERAL DIRECTOR, AZUR

> We celebrated 100 years in 2023. Why? In 1923 our core business was established: paints, coatings, and resins. We are a family business—the family Farber, which was quite reputed in Timișoara.

A lot of people ask what Azur is doing, because as our strapline says, our heritage is our evolution. We are constantly changing. What we did 100 or 50 years ago does not exist anymore. We evolved from oils and soaps to paints and coatings, to resins today.

We had strong brands. People here know Palux for parquet or Lazur for wood varnish—they were used like "Xerox" for copying. But we were a small player, and the previous management was not capable of building on those brands. So, at the end of last year, we took a tough decision and said goodbye to paints and coatings. That chapter is now history.

Today, our core business is resins—the binder needed for any coating in the world. We provide polyester resins for the inside of metallic cans for beer, Coke, or processed food, shipping worldwide with a 10% market share. We've also moved into niche products like aroma concentrates used to flavour food for chickens and pigs, stimulating them to eat constantly to reach slaughter size in just 20 days.

The chemical industry evolves. Azur was a huge factory during the communist period, employing thousands. That's not the case anymore. Process efficiency means we are more automated, with about 100 employees today. The ownership of Azur will also change; our family has decided to step out, so in 2026, Azur will have a new owner.

ALEXANDRU MEHEDINȚU
OPERATIONS DIRECTOR, AZUR

> I started four years ago to reintroduce Azur to the Romanian market. Our products have evolved with the times. Currently, we produce high-quality synthetic resins for industrial users, which we export all over the world.

The Romanian chemical industry was superb, but now it is quite limited, with Azur being one of the few remaining players. We are the only ones still producing certain resins in Romania. We need to adapt to navigate the turbulent times ahead, analyzing everything from management to market trends. One strategic direction is implementing artificial intelligence for process control. We are focusing on niche, high-profitability markets to ensure our long-term prospects.

ALINA PERDIVARĂ
FORMER RESEARCH & DEVELOPMENT DIRECTOR

> Driven by curiosity, I started at Azur in the Research and Development Department on May 5, 2003. At first, nothing I had learned at college seemed relevant. I was lucky to work with Maria Sandei, a technician who knew everything about the practical side of paints, and Mr. Țig, the applicator who tested our creations. What is paint if it just sits on a shelf? You have to see it applied.

When I was offered the Directorship in 2008, I was daunted by the responsibility, feeling it had come almost too quickly. Yet, I stepped into the role.
Then, after returning from maternity leave in 2010, I encountered a factory that felt profoundly changed—the Azur I came back to was not the one I had left. The team was smaller, less motivated. The labs were in an old, unheated building. It was a low point. But we rebuilt. We moved the labs, secured new equipment, and hired fresh graduates. It was a rebirth.

The work was a constant puzzle, like replacing lead-based siccatives or toxic solvents. This innovation, driven by legislation, was at the heart of our work. But I must share my biggest mistake. Under pressure, I was working with a massive spreadsheet and for a blue paint, I accidentally selected black in the formula. The result was several tons of the wrong colour. I cried, not from fear, but because I had failed my own standards.

The production director, Miriana Văicin, called me in. She was incredibly kind. She told me to relax, that it wasn't an ugly colour, and thanked me for my hard work, saying it certainly wouldn't be my last mistake. She taught me about leadership and grace. That lesson in humanity has stayed with me more than any technical achievement.

I've now left the factory to teach at the Azur Technological High School and to do my PhD. It feels like a continuity. I hope to pass on all the experience I gained—not just the chemistry, but the resilience, the passion, and the understanding that progress is built on both our successes and our forgiven mistakes.

VM,
DIRECTOR OF TIMOȘOARA BRANCH OF ICC FORMER RESEARCH & DEVELOPMENT / INTERNATIONAL COMMERCE, AZUR

> The real story of Azur is about the people and the knowledge they hold. Azur has truly skilled operators. When we started working with the American company Valspar, we had to implement 35 new resin recipes. Incredibly, we did it without any laboratory or pilot testing.

We only had three failed batches. That speaks volumes about the quality of our people.

This knowledge isn't just technical; it's about human connections. Commerce is done with people. During the pandemic, we saw new people who only knew how to work with software.

A provider once called us, desperate for raw materials. I asked who they usually bought from, and it turned out their distributor sourced it from the same producer we used. Because of our relationships, we could solve their problems instantly. You can't get that from a computer.

In the end, Azur persisted not because of profit, but because of people. Mr. Farber, descendant of the founders, repurchased the factory as an act of sentimental restoration, a move his wife initially resisted. Her perspective shifted not after reviewing a business plan, but after observing the factory's social fabric firsthand in Romania. This decision frames Azur not as an asset, but as a legacy—a human institution whose worth is measured in continuity and connection, not just currency.

Memories from the factory floor

The following interviews were conducted in 2023 by the anthropologist Antal Agota with workers from Azur's water-based paint section—a smaller, tight-knit unit where only three operators worked a single daily shift. These personal accounts, captured in the office of the section's manager, preserve the voices and daily realities of the team just before the section's closure in 2024, documenting a specific way of life and work that has since passed into the factory's history.

TEAM LEADER OPERATOR
WATER-BASED PAINTS SECTION

> I started at Azur in 1988. I began in resins and moved to the water-based paint section when it opened around 2000. I've worked on every machine on the production line.

My day starts early, from 6 to 14. From 6 to 7, before the others arrive, I prepare the ground, and at the end of the shift, the team cleans and prepares the primer for the next day. I live about 2 km away. I drive my wife and

Excerpt from an advertisement in a magazine. Marketed under the name "Pallux," this parquet varnish developed by Azur became a very popular product in Romania starting in the 1980s.

son to work when our shifts align. I'm dissatisfied with the salary and the workload. We bought our apartment and have a 3100 RON monthly bank installment. I'm not very good with money. When my parents worked the land in Oltenia, we spent less on food. Now they are old and sick, and no one works the land anymore. I would, but I have no time or means. We manage carefully, and sometimes we cut back on food expenses.

OPERATOR
WATER-BASED PAINTS SECTION

> I've been at Azur since 1989, after finishing the Azur vocational school, and I've been a chemical operator since the beginning, working in several sections.

My schedule is from 7 to 15. We get a weekly plan, but we decide the sequence of work ourselves on the shop floor. We decide what we start with and what the priorities are, and how it would be easier for us. Only if something is an emergency does that change. My husband also works at Azur. We live nearby and walk. Our parents in the countryside supply us with food from their land. We manage to save a little money each month, but not much. We are careful with spending, especially on vacation.

MAINTENANCE MECHANIC

> I've been at Azur since 1990, right after finishing vocational school. I started as a chemical operator and have worked on every machine in the section.

I know the entire production line—I can operate the forklift or dose materials, even though it's not in my job description anymore. I became the maintenance mechanic a few months ago after the previous one retired. I work from 7 to 15 and live just five minutes away, so I walk. I plan my workday from home, thinking about what needs to be done. I make most decisions independently; the important thing is that the machinery runs. My wife also works at Azur. We have no children. We live in an apartment but visit my parents in the countryside on weekends. They supply us with meat, eggs, and vegetables, so we don't buy those. Together, my wife and I save about 100 euros a month.

OPERATOR
WATER-BASED PAINTS SECTION

> I started at Azur in July 2022. Before that, I worked in an aluminum factory with two shifts.

I'd leave home at 6 and return at 7 after 13 hours, alternating between night and day shifts weekly. The pay was the same as here, but the work was much harder physically. Here, I work from 7 to 15 in the water-based paints section, but I'm in the locker room by

Excerpt from an advertisement in a magazine. Types of soaps produced by Azur included names such as Dream, Pygmalion, Bud, Lily Milk, and Dwarf.

6:45. The work is more focused and the environment is better. I wake up at 5, leave by 5:30, and catch the bus at 5:50. Azur pays part of my bus pass—250 of the 360 RON. My wife works at another factory and earns more. We have a daughter in third grade who goes to and from school alone. We have some land but don't work it—no time, and fodder is expensive. Sometimes we run out of money and borrow from my mother-in-law. We have to buy everything we need, and living in the countryside is expensive—store prices are higher there.

ȚONA RAMIRU
MULTIPLE DEPARTMENTS, SOLVENTUL

My name is Țona Ramiru, and I am 74 years old. I spent my working life in the factories of Timișoara, a journey that took me from high-voltage electricity to chemicals and, finally, to feathers and food.

I began at I.R.E.T., where, as the youngest worker, I was assigned to a phenomenal 400,000-volt installation. Later, I moved to Solventul, a massive chemical enterprise with 4,000 employees. I worked as a foreman responsible for the electrical station that powered the entire plant. The work was strict and dangerous. Cigarettes had to be left on shelves at the gate; bringing one inside was disastrous due to the explosion risk.

I witnessed this danger firsthand. There was one explosion caused by a simple mistake—a pipeline section that wasn't emptied before welding. It exploded, killing three people on the spot. I went to the hospital to see a young man from my team. He was black, like a piece of coal. Under morphine, he was aware he was dying. I've never seen anything like that in my life.

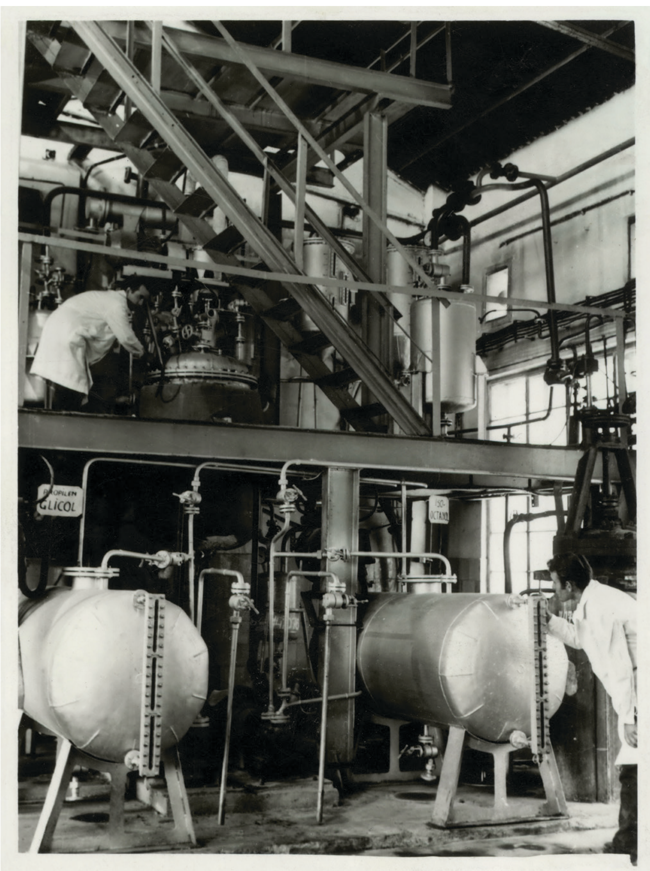


Image from the Solventul Factory (ca. 1970–1980).
Image courtesy of Daniel Caius Scaueriu.

Yet, the plant was also extraordinary. We worked with state-of-the-art technology, and a section was even built by a team of about 12 Japanese engineers. It's a shame it was all destroyed so quickly after the Revolution.

After Solventul, I worked at Pencoop, processing feathers and food solely for export. We had a frog slaughterhouse for the French, a rabbit slaughterhouse for the Italians, and processed goose feathers for the Germans. The salaries were small, but the advantages were multiple.

Life was different back then; where you worked, that's where you lived from. At the end of the week, they gave us, according to a list, a goose, eggs, or things like that.

Housing was provided by the state through the factory. I started with a studio, then got a two-room apartment when I got married and had a child, and a third home when I had a second child.

There was also time for life outside work. On New Year's Eve, there were gatherings and balls for young people. Everyone looked forward to their scheduled summer holiday, always spent at the seaside or in the mountains. No one stayed home.

Pencoop lasted only about two more years after the Revolution. After it closed, I went private, buying a minibus from Germany to go into tourism. Everyone was struggling to buy a car; it was much more important than an apartment back then.
I feel nostalgic about that period. The work was hard and sometimes tragic, but there was a structure and a community. We had our perks, our homes, and our holidays. Now we have other perspectives.

POPOV ANIMARIA
QUALITY CONTROL, GUBAN FACTORY

My name is Popov Animaria, and for 30 years, from 1969 to 1999, I worked at the Guban factory in Timișoara.

I was in the quality control department for plastics and artificial leather. Our work was strict, governed by one unwavering rule: if a product did not meet standards, it could not be exported. Even a single crooked line, a stitch out of place, or mismatched colours was enough. Those imperfect pieces remained for us, the domestic market, while only the flawless were sent abroad—not just to Europe, but as far as Afghanistan.

We were held accountable for every bit of material. You had to explain what you used and what you returned; losses were not tolerated. Our schedule was demanding. We started at 6 or 7 in the morning, often working Saturdays and Sundays. Having one Sunday off per month was considered a holiday. There was no time for chatting. Everyone knew their task and focused on their work.

Holidays like Christmas and Easter were just ordinary workdays. I remember many New Year's Eves when, while others celebrated, we were still inside, delivering goods. The time for celebration came later. Despite the pressure, a sense of community held us together. We would gather for a coffee or a sandwich when time allowed.

This spirit is why I stayed so many years in one place. We looked out for one another. If you needed something for your home—a tablecloth or a shopping bag—you could go to the director for a stamped approval and receive it. If it wore out, you could get another. The same was true for shoes. With approval, we could go to the factory store and choose a pair.

We eagerly waited for items rejected for export due to a tiny, almost invisible flaw.

I continued after the 1989 Revolution, but when I saw the restructuring begin and layoffs starting, I decided to leave. I had the age and the years, and it felt like there was no point in staying. We were conscientious, we worked hard, and we built a community. Otherwise, we wouldn't have lasted.

Old can of parquet wax produced by Guban (ca. 1970). Object courtesy of the FABER archive.

Young Matters

5.1

Young Matters
The Workshop

Now in its third edition, Young Matters, the pedagogical program of Design Signals, invites students from disciplines related to designing our futures to join a summer school where their ideas, skills, and tools can be activated in a collective space for learning and making. With a focus on Timișoara, Young Matters proposes a site-specific approach: connecting ideas with context through lectures, field explorations, and experimental workshops.

This year's program unfolded under the annual theme of chemistry, fundamental to all design processes. Three workshops were carried out during the one week-long summer school: Timișoara: The City Beneath the Skin by Ro Pérez Gayo with Oana Gavriliuc explored the city's "chemical ecologies" through sensorial mapping; Air Quality by Fabio Salvadori, Federico Santarini with Marian-Emanuel Ionașcu, asked students to prototype visualisations and urban interventions for the communication of air quality data; Rare Earth – design and material power by Anna Diljá Sigurðardóttir examined copper as both a resource and cultural material, connecting Romania's mining heritage to the global energy transition.


DESIGN SIGNALS
Young Matters
Brumă Iulia
The metal that made us
Rare Earth by Anna Diljá
From the dawn of civilization, before iron and before oil, there was copper. This documentary traces humanity's 6,000-year relationship with its first metal: a force that built empires, shaped rituals, and sparked revolutions. From sacred relics of ancient Egypt to the lifeblood of Roman aqueducts, copper has always been more than matter—it is a symbol of power, beauty, and belief. As the Industrial Revolution wired the modern world, copper became its silent heartbeat. Today, it drives the green energy transition, yet remains largely unseen. Filmed across continents and centuries, this story weaves together the voices of miners, archaeologists, and artists to ask: Can a metal hold memory? And as we rush into the future, what burdens will we demand copper to bear next?

STUDENTS

Ionel Vasile Andras
Iulia Brumă
Radu-Mihai Burcea
Diana Coseri
Maya Ceplenschi
Teodora Dinu
Ange Dusingize
Mirela Filimon
Cristina Gătăianțu
Andrada Haiduc
Paula-Ioana Iancu
Ilinca Rădoi
Adela Șerbulescu
Ana-Dora Szigeti
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Bogdan Vizitiu

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DESIGN SIGNALS
Young Matters

Filimon Carmen-Mirela
The Seat between Tradition and Innovation

Rare Earth by Anna Diljá Sigurðardóttir

Copper has been used since the beginning of time, from objects to the invisible thread of modernity. Once believed to bring us closer through technology, it has often left us more distant. This project merges traditional handcraft with CNC precision. At its heart lies a simple, ancient game engraved in copper, inviting people to slow down, share space, and connect face-to-face. Here, copper carries not electricity, but ideas, memory, and dialogue.

DESIGN SIGNALS
Young Matters

Iancu Paula, Mage Andrei, Jebelean Răzvan
The synesthesia experience

Workshop Air Quality, with Fabio Salvadori, Federico Santarini,

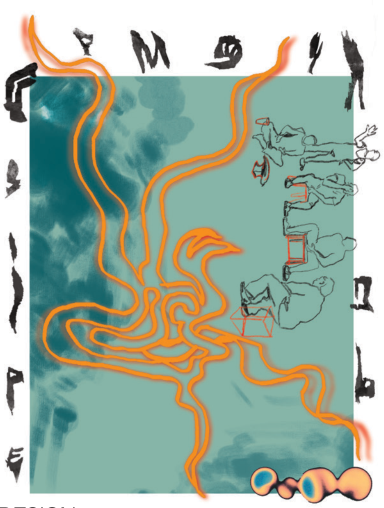
The project makes air quality in central Timișoara perceptible through an interactive installation: a translucent balloon that changes colors and sounds in real time based on AQI, dust, and temperature levels, inspired by synesthesia. A companion mobile app enhances accessibility by offering both visual and audio data, including support for the visually impaired. The initiative raises awareness, promotes inclusivity, and transforms invisible environmental data into a vibrant urban experience.

DESIGN SIGNALS
Young Matters

Bogdan Vizitiu
Constellation of Timisoara

Rare Earth workshop by Anna Diljá Sigurðardóttir

As copper once carried current, it now carries memory. This glowing map retraces Timișoara's first electric tram lines, transforming infrastructure into identity. By illuminating the city's early paths of progress and their development, the work invites us to see these lines not just as transit routes, but as threads of connection, and shared legacy.

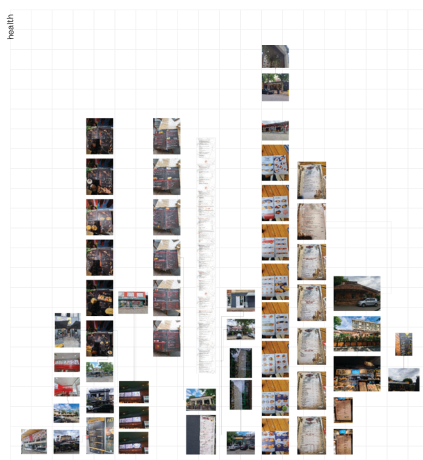


DESIGN SIGNALS
Young Matters

Rădoi Ilinca
Coppersmiths story

Rare Earth by Anna Diljá Sigurðardóttir

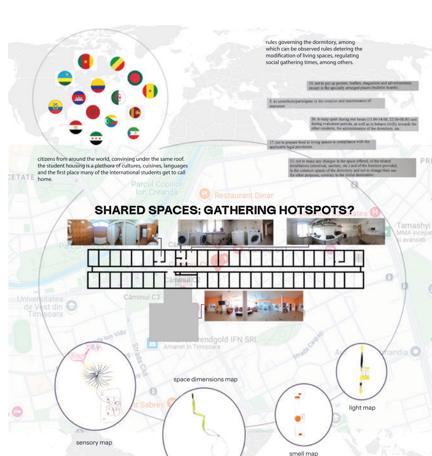
The project explores how copper, beyond being a material, becomes both a social symbol and cultural epicenter. It maps the local copper smith craft and its role as an emblem for Roma people. From a social and anthropological view, it highlights copper craft as a living practice, showing how Romani communities preserve it despite systemic discrimination. Amid accelerating industrialization and marginalization, copper emerges as both resource and symbol of resistance: "We're still here."



DESIGN SIGNALS
Young Matters

Cristina-Elena Gataiantu
The City Beneath the Skin

What do we really choose when we eat? I explored the restaurants and menus in the student campus of Timisoara and mapped them in different ways: based on price and how healthy the meals are. The aim of this project is to show that food is not only about how cheap or fast it is, but also about the impact it has on our health. By comparing these two aspects, we can better see where the balance lies between saving money and making nutricious choices



DESIGN SIGNALS
Young Matters

Ange Dusingize
The city beneath the skin

In our investigationof the C8 buidling within the student complex, emphasis was put on experiencing the space not just as it's resident but also though the lens of first time visitors; wherein fisrt time visitors had a strong rsensory reactions to the spaces caused by stimulants smell, the amount of light, the minimal dimensions of the room among others. The space thoug populated with sideveristy, did not strike us as a favorable gathering space, instead most of the social aspects of the international student life happened outside it, in the multitude of restaurants and shops within the Complex.

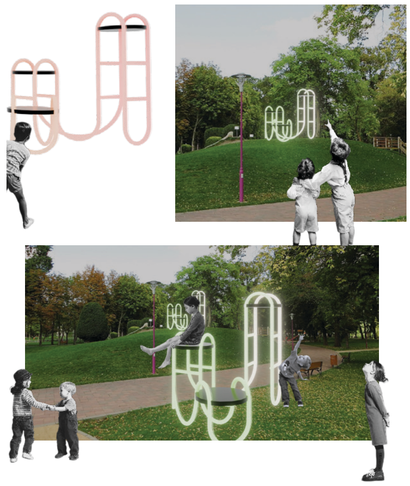
DESIGN SIGNALS
Young Matters

Teodora Dinu, Ionel Andras

Air Threads

Workshop Air Quality by Fabio Salvadori & Federico Santarini

The project turns air quality into a visible, shared experience through three connected elements: bus screens, station panels, and a smart bench. Onboard screens show a metro-style route where stations shift color in real time according to air quality. Panels extend this line onto the city map w pollution and traffic gradients. The bench translates the same index into light, creating a sensory experience. This system connects people, data, and urban space, making the city a fabric, threads weaving the impact of our actions on everyday life.



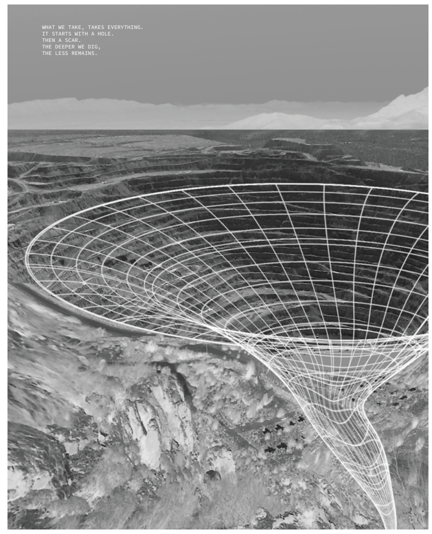
DESIGN SIGNALS
Young Matters

Vass Krisztina, Răzvan Jebelean

ClimbO_2

Workshop Air Quality with Fabio Salvadori, Federico Santarini

ClimbO_2 is a playground structure designed to raise awareness about air quality through play. Inspired by the shape of the CO2 molecule, it features LED lights that change color based on real-time air conditions: green for clean air, red for pollution. More than just a climbing frame, ClimbO_2 encourages environmental awareness from a young age by combining design, technology, and education in a playful yet purposeful way.



DESIGN SIGNALS
Young Matters

Radu-Mihai Burcea

Mine Reclamation.

Rare Earth Workshop by Anna Dilja

Mining doesn't just remove minerals – it unravels millennia. The soil we disturb has been shaped by time, pressure, and life itself. No reclamation effort, no engineered fix, can replicate the complexity of what was lost. What took thousands of years to form is reduced to rubble. After extraction stops, the scars remain. Chemicals seep into rivers, dust clouds silence nature, and the damage lingers for generations. The project aims to showcase these lasting impacts, revealing both the visible wounds and the hidden costs of mining.

DESIGN SIGNALS
Young Matters

Szigeti Anna-Dora

The city beneath the skin

Do you know what you're wearing?
We went out on the streets and asked young people if they cared about the materials in their clothes. Many don't realize that chemicals are hidden in fabrics we wear every day. This project highlights the importance of being conscious about what we put on our bodies and choosing clothing materials that are safer for us and for the planet.

DESIGN SIGNALS
Young Matters

Brumă Iulia

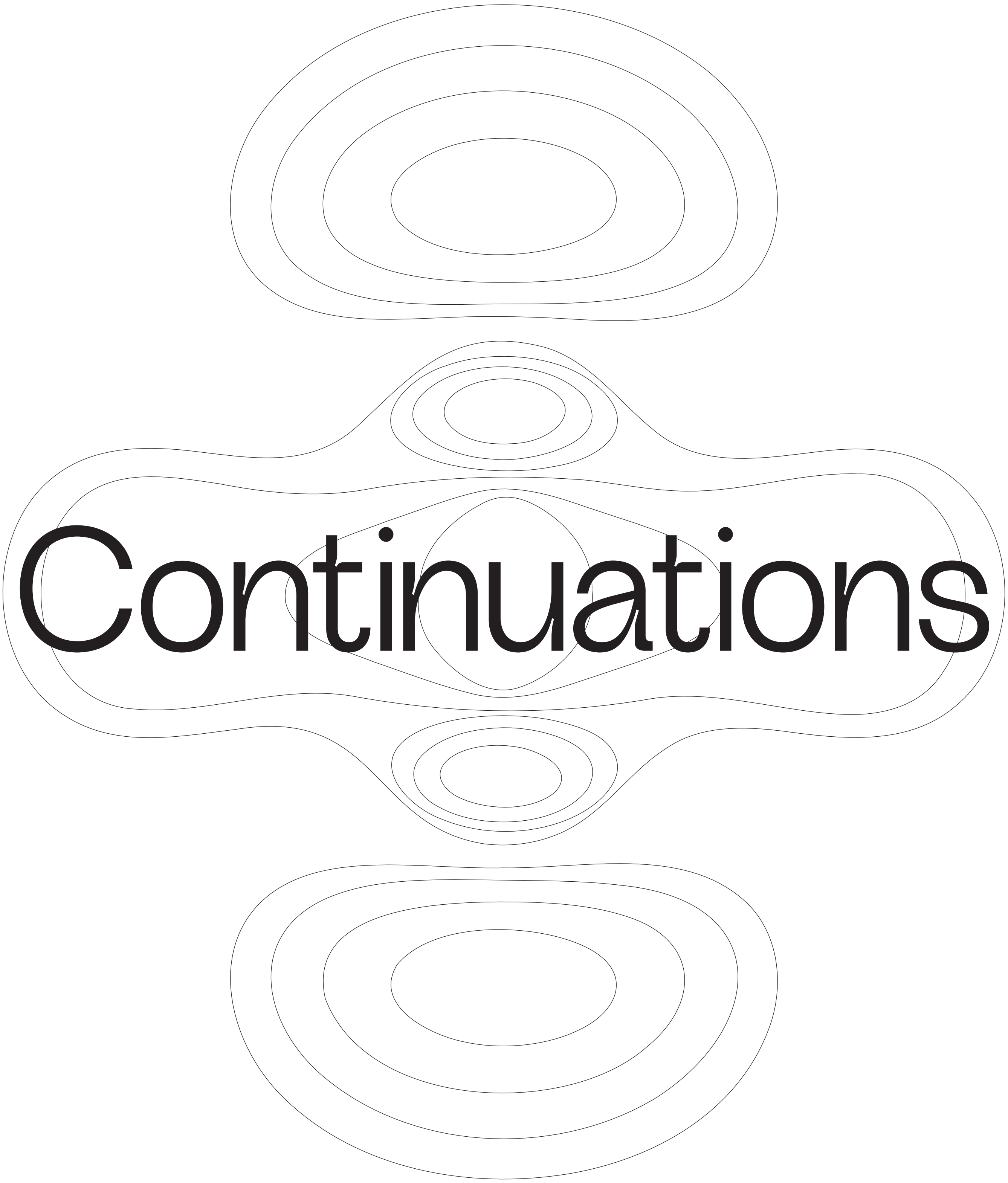
The metal that made us

Rare Earth by Anna Diljá

From the dawn of civilization, before iron and before oil, there was copper. This documentary traces humanity's 6,000-year relationship with its first metal: a force that built empires, shaped rituals, and sparked revolutions. From sacred relics of ancient Egypt to the lifeblood of Roman aqueducts, copper has always been more than matter—it is a symbol of power, beauty, and belief. As the Industrial Revolution wired the modern world, copper became its silent heartbeat. Today, it drives the green energy transition, yet remains largely unseen. Filmed across continents and centuries, this story weaves together the voices of miners, archaeologists, and artists to ask: Can a metal hold memory? And as we rush into the future, what burdens will we demand copper to bear next?

6

Continuations



6.1

Chemical Bonds: Metabolic Design and the Hormonal Infrastructures of Care

Ro Pérez Gayo

Chemical bonds do more than hold molecules together; they connect our bodies to our environments, infrastructures to their histories, and intimate gestures to collective possibilities. A bond is both affective and material—a force that stabilises matter and a relation that makes care possible. To live hormonally is to consciously inhabit these connections, engaging with chemistry not as a passive background process, but as an active medium of self-becoming. In this view, metabolism emerges as a design space, where substances, infrastructures, and sensations continually reshape one another.

I write from inside this chemistry. Every five days, a measured dose of oestradiol passes through my hands and into my body. This routine anchors my days and sets the tempo of my thoughts. Hormone replacement therapy is often framed as a medical treatment—a protocol for aligning physiology with identity. Yet its lived reality exceeds this description. HRT unfolds as a sequence of adjustments, calibrations, and responses, a process that mirrors the practice of design: an iterative engagement with materials whose effects cannot be fully known in advance. Each dose becomes a subtle negotiation between possibility and limit, between the promise of chemistry and the contingencies of access.

To describe HRT as design is not to idealise transition or to overlook the systemic harms that shape its conditions. Instead, this framing highlights how trans women must navigate systems that are routinely failing. Hormones are among the most deliberately engineered substances in circulation—synthesised with precision, packaged to strict technical standards, and distributed through global logistical chains. Yet the infrastructures governing their access remain uneven, exclusionary, and vulnerable to political hostility. Many trans women encounter clinicians who question their legitimacy, pharmacies that refuse service, and bureaucratic frameworks that mandate psychiatric scrutiny. In this context, taking hormones is not merely a personal or therapeutic decision, but an inherently political one. For many, HRT operates as a form of harm reduction: a chemical strategy for sustaining oneself within a social order structured by transmisogyny, administrative violence, and economic precarity.

Metabolic design describes this terrain: a field where chemical, institutional, and affective processes interlace to produce conditions of liveability. It shifts attention from novelty and invention towards the work of sustaining coherence within unstable systems. Through this lens, hormones are not simply biomedical tools; they function as relational media that bind individuals to collectivities, bodies to infrastructures, and human metabolism to planetary circulation. The gestures of HRT—adjusting dosage, tracking shifts in perception, managing supply interruptions—reveal how design emerges from repetition, vulnerability, and care.

HRT exemplifies how design operates across multiple registers simultaneously. At the disciplinary level, it encompasses the instruments and institutional systems that frame care: syringes, lab assays, dosage guidelines, and regulatory standards. At the practical level, design appears in the adaptive strategies through which trans communities reinterpret or circumvent these systems, generating forms of expertise grounded in experience rather than institutional authority. At the ontological level, design describes the reciprocal shaping of bodies and chemicals—the capacity of matter to reorganise form and relation. Living hormonally requires navigating between these registers, attending simultaneously to the demands of institutions, the rhythms of metabolism, and the weight of social expectation.

To persist within these conditions is itself a form of design. Each cycle of administration, every disruption navigated or workaround devised, testifies to a commitment to continuity in the face of structural neglect. Hormonal care thus becomes a practice of maintaining coherence against pressures toward erasure. It demonstrates how design can be understood not as the creation of new forms, but as the labour of sustaining relations within environments that actively threaten its dissolution.

Traces of (Self-)Design in HRT History

The dominant history of hormone therapy is often narrated as a sequence of medical breakthroughs, beginning in early twentieth-century endocrinology. Researchers isolated sex hormones, established their molecular structures, and constructed theories linking physiology to gender. Institutions such as Magnus Hirschfeld's Institute for Sexual Science experimented with hormonal interventions, thereby shaping the foundations of what would become gender-affirming medicine. In these accounts, trans people appear primarily as beneficiaries of scientific progress, their lives framed as evidence of medicine's expanding capacity to correct physiological deviations.

Yet alongside this canonical narrative runs a quieter, less visible history of experimentation and self-design. Long before sex hormones were standardised and clinically regulated, trans and gender-diverse individuals sought out substances they believed could alter their embodiment. Information travelled through informal channels: whispered conversations, marginal publications, coded advertisements, and later, through message boards and early internet forums. This knowledge often emerged from trial and error. One person might discover that a particular contraceptive pill contained a useful form of oestradiol; another might devise a method for splitting tablets to regulate dosage.

Together, these practices constituted a dispersed, improvisational research apparatus—a system of knowledge grounded in lived experience rather than institutional authority.

Melinda Cooper and Catherine Waldby describe this form of labour as "clinical labour"—the embodied work that sustains medical knowledge while remaining unrecognised within its official archives. Trans communities have long engaged in such labour, generating empirical insights into dosing strategies, side effects, and embodied responses. Their contributions shaped the practical realities of hormonal care long before formal studies addressed these questions.

The ongoing community experimentation with progesterone offers a striking example. For decades, endocrinologists dismissed its significance in transfeminine care, citing insufficient evidence for its role in breast development or emotional modulation. Nevertheless, trans women across online forums and mutual-aid networks continued to test its effects, sharing accounts of deeper sleep, shifts in mood, changes in breast shape, and enhanced emotional balance. These observations circulated laterally, accumulating as a form of experiential evidence that refined community protocols. When researchers at Amsterdam UMC confirmed in September 2025 that progesterone supplementation increases breast volume in trans women, they validated what communities had already understood through their own experiments. Scientific authority thus belatedly acknowledged insights produced through non-institutional forms of inquiry.

Within formal clinical infrastructures, design logics operate in distinctive forms. Many gender clinics follow protocols that stage transition as a linear sequence: beginning with testosterone suppression, followed by surgical removal of the testes, and culminating in feminising hormone regimens. Anti-androgens function as preparatory technologies, clearing the biochemical field for more stable feminisation. For some, this progression aligns with their desires; for others, it imposes a narrow vision of what trans embodiment should be. The protocol presumes a linear, binary horizon of change, mapping care onto a trajectory that extends from male to female as if these were fixed points. Such choreography reflects institutional assumptions rather than lived realities. It encodes gender into a pharmacological sequence, revealing how design at the institutional level can constrain the possibilities of design at the embodied level.

Institutional exclusions exacerbate these tensions. Gatekeeping practices, diagnostic requirements, and insurance limitations create barriers that disproportionately impact those already marginalised by race, class, disability, or migration status. For many trans women—particularly those working in informal economies or navigating hostile bureaucracies—access to formal transition-related care becomes precarious or impossible. Self-medication thus emerges not as deviance, but as necessity. Communities construct alternative infrastructures of care through partnerships with sympathetic clinicians, shared tutorials on safe injection technique, and collective purchasing arrangements to mitigate drug shortages. These practices illustrate how design becomes infrastructural: not a speculative gesture, but the continual labour of constructing conditions that allow care to take place.

John Dewey proposed that experimentation begins when established paths fail—when life becomes "so hemmed in and constricted" that one must devise new empirical situations. Trans histories have long unfolded under precisely such conditions. Bureaucratic delays, medical suspicion, and economic precarity force individuals and communities to create new ways of sustaining themselves. Design, in these contexts, arises from necessity rather than excess. It is a means of navigating constraint, a practice of crafting strategies that hold life together in the absence of reliable support.

Institutional medicine often presents itself as the arbiter of safety, yet its frameworks are shaped by epistemic hierarchies that privilege certain forms of knowledge. Sara Ahmed's account of the "happiness duty" clarifies how institutions define success through conformity: bodies are deemed healthy when they align with normative expectations of stability and recognisability. In gender clinics, this orientation manifests as an emphasis on protocol compliance, rendering trans life legible primarily through bureaucratic categories.

Community practices, by contrast, foreground liveability over compliance. They ask whether a dosage feels right, whether daily experience becomes more bearable, whether the rhythms of life grow more coherent. Here, care emerges as a relational practice, not an institutional metric. HRT becomes harm reduction in the fullest sense: a strategy that addresses not only the distress of dysphoria but also the injuries inflicted by medical exclusion, economic precarity, and social hostility.

The history of HRT, understood through these intertwined narratives, reveals a practice whose design has always been distributed. Laboratories, clinics, community forums, and individual bodies all participate in its continual shaping. Hormonal care thus occupies an ambivalent position: it functions as both a tool of regulation and a medium of autonomy, as much a product of industrial pharmacology as a practice of collective improvisation. Ultimately, it forms an assemblage that perpetually reconfigures the boundaries between bodies, institutions, and worlds.

Routine as Method: Maintenance, Calibration, Attunement

Understanding HRT as an infrastructure requires attention to how it is lived, and routine provides that entry point. Far from a mechanical repetition of clinical acts, routine functions as the temporal architecture through which hormonal life unfolds—a mode of inhabiting an assemblage, a rhythmic negotiation between substances and sensations, bodies and systems. Through routine, design becomes experiential, distributed across gestures that accumulate knowledge and sustain continuity.

In design discourse, innovation has long overshadowed maintenance, yet the everyday work of upkeep often constitutes the most vital dimension of care. Scholars such as Steven Jackson and Shannon Mattern have shown that maintenance is not a secondary concern but a generative practice in its own right. Hormonal routine exemplifies this dynamic. Daily or weekly engagement is not merely a sequence of repeated tasks; it is a situated inquiry grounded in embodied observation. Fluctuations in energy, mood, temperature, sleep, or appetite function as data points that, over time, accumulate into forms of understanding unavailable through laboratory metrics alone. The body becomes both the site of change and the instrument of its measurement, gradually forming an embodied epistemology inseparable from lived experience.

This interpretive labour never occurs in isolation. Routine binds individuals to an array of material and social infrastructures: syringes and patches, vials and alcohol swabs, laboratory diagnostics, appointment schedules, peer conversations, and shared protocols. Hormonal effects mingle with sleep, stress, interpersonal dynamics, and environment, rendering the body both the object and the instrument of inquiry. Together, these elements form a relational ecology through which hormonal care is enacted and sustained.

The fragility of this ecology becomes starkly visible when its infrastructures falter. A delayed prescription, a national drug shortage, the discontinuation of a familiar formulation, or a clerical error that suspends access can unsettle not only biochemical balance but the very tempo of care. Such disruptions reveal the extent to which bodily continuity depends upon logistical and bureaucratic systems that are unevenly maintained, politically contingent, and often indifferent—if not actively hostile—to trans survival.

Yet within this precarity, routine also cultivates creativity. It becomes a temporal strategy for constructing continuity in environments that routinely fracture it. María Puig de la Bellacasa's concept of "care time" is instructive here: an understanding of care as a slow, durational engagement rather than an act of rapid problem-solving. Hormonal life models this ethic. The gestures of drawing up a syringe, applying a patch, or smoothing gel across the skin are neither merely technical nor purely symbolic; they are moments in which relation is renewed despite the obstacles imposed by broader systems.

Moreover, routine introduces an alternative politics of time. Biomedical frameworks often cast transition in linear terms, as a progression toward stabilisation or resolution. Capitalist temporalities, meanwhile, emphasise efficiency, productivity, and optimisation. Hormonal time resists both. It is cyclical and recursive, marked by a repetition that is never identical. Each dose reinstates the conditions for change, inviting reflection and adjustment rather than promising arrival. Its temporality is one of balance rather than completion—an ongoing negotiation rather than a finite project.

Approached as a design method, hormonal routine foregrounds the labour inherent in maintenance. It reveals how knowledge is produced not through dramatic intervention, but through attentive repetition. Richard Sennett's reflections on craft—particularly his conception of it as a "repetition that changes"—resonate here. Hormonal care develops as a craft of the body, honed through subtle recalibrations that accumulate as embodied expertise. This craft is not only tactile and sensory but also social and infrastructural, shaped by the availability of materials, the reliability of supply chains, and the trust cultivated within communities.

Ultimately, the routine of HRT radiates outward, linking individual acts to wider structures. Each dose depends on global pharmaceutical production, regulatory frameworks, shipping logistics, and labour distributed across continents. Recognising this interconnectedness adds another layer to the meaning of routine. It becomes a site where personal survival intersects with collective conditions, a point at which embodied experience illuminates the broader entanglement of design, politics, and metabolic life. Through routine, the everyday becomes a space where design and endurance converge, revealing how continuity is fashioned under conditions that rarely guarantee it.

Intimacies: Bodies and Hormones

Understanding hormonal care as a design practice requires attention to the intimacy of the biochemical encounter. Hormones do not move through neutral tissues; they carry the histories of their extraction, synthesis, and cultural framing. Each molecule that enters the bloodstream brings with it industrial processes and scientific narratives about sex, normativity, and proper embodiment.

Biomedical discourse has often imagined hormones as instruments of inscription, as if chemistry imposes identity onto passive flesh. Feminist technoscience complicates this view. As Nelly Oudshoorn has shown, sex hormones were not simply discovered but produced in laboratories as material expressions of cultural ideals about masculinity and femininity. Their naming stabilised gender hierarchies in chemical form, embedding normative assumptions into substances later taken up by those whose lives deviate from such norms.

Pharmacological effects, however, never arise solely from molecular structure. Gregory DeGrandpre emphasises that drugs act through context, expectation, and the infrastructures that condition their movement. Hormones follow this relational logic. Their transformative power depends on dosing practices, embodied histories, emotional conditions, and the regulatory or informal pathways that shape access.

These intimate biochemical relations rely on infrastructures that remain largely invisible in everyday practice. The oestradiol that enters a body has already moved through manufacturing plants, shipping networks, customs systems, and regulatory frameworks. Interruptions—shortages, delayed shipments, regional restrictions—reveal how personal continuity depends on systems that are unevenly distributed and politically vulnerable. Hormonal care is embedded in this broader material history long before it reaches the skin.

Alongside these formal infrastructures, lateral forms of relation shape how hormonal care is practised and understood. Friends remind one another of injections, partners help interpret shifts in mood or sensation, and online communities compare experiences with timing, dosage, or formulation. These networks support kinds of knowledge often absent from clinical spaces, turning lived experience into a shared method.

Within these communal circuits, more improvisational practices emerge. DIY hormone procurement and open-source compounding instructions circulate in encrypted groups; surplus medications are redistributed; and informal distributors occasionally step in to bridge gaps produced by bureaucratic refusal or market scarcity. They operate as pragmatic mediators within systems that routinely fail to provide stable access to essential medication, functioning both as alternatives to clinical care and as adaptive strategies shaped by structural exclusion.

Hormonal change is neither linear nor uniform, and plasticity gives this intimacy its distinctive quality. In Catherine Malabou's terms, plasticity involves the capacity to receive and to give form without fixed direction. Even though substances and clinical protocols are structured around an implicit cisnormative template of womanhood, the body metabolises hormones in ways that often diverge from this script. A long-anticipated physical change may remain subtle, while shifts in sleep, mood, or perception take precedence. These divergences reveal hormonal care as co-design: a negotiation between biochemical potential and embodied response rather than the realisation of a predetermined form.

To design with hormones is thus to engage these entanglements with attentiveness and care. Transformation emerges from the interplay of chemistry, experience, and relation. Hormonal intimacy makes clear that design here is not a single act, but a continuous, interpretive process through which bodies and environments shape one another.

Estrogenic Ecologies: Leakage, Relation, Planetary Metabolism

Hormones rarely remain confined to the bodies that metabolise them. Once administered, they move outward into wider chemical currents, entering wastewater systems through excretion and slipping into rivers, soils, and sediments via agricultural runoff or pharmaceutical disposal. In these environments, synthetic oestrogens and related endocrine-active compounds circulate alongside other endocrine-disrupting substances such as pesticides, plasticisers, and industrial by-products. Together, they interact with the hormonal systems of fish, amphibians, birds, and even plants, subtly reshaping patterns of reproduction, growth, and behaviour across multiple species.

Heather Davis describes such accumulation as a form of "geologic indigestion." Her formulation captures how synthetic residues lodge themselves in the earth's metabolic processes, altering them from within. A molecule originally designed to regulate a single person's hormonal balance becomes entangled in planetary cycles, producing effects far removed from the clinical spaces in which it first entered circulation. This redistribution troubles conventional boundaries between medicine and pollution, revealing how the metabolic work of hormone therapy inevitably participates in environmental processes, regardless of intention.

Discussions of these transformations in mainstream media typically adopt the language of alarm. Reports of feminised fish or intersex amphibians often appear accompanied by moralised commentary, implicitly linking ecological disruption to perceived threats against the gender order. As Giovanna Di Chiro observes, such narratives operate through an eco-heteronormative logic that interprets deviations from binary sexual form as evidence of ecological collapse. What presents itself as environmental concern often conceals a deeper cultural anxiety about the erosion of what counts as natural, stable, or recognisable sex.

A different set of interpretive resources emerges from feminist and queer ecologies. Karen Barad's notion of intra-action and Stacy Alaimo's account of trans-corporeality both reject the assumption that bodies and environments stand apart. They describe instead a world in which matter is inherently relational, where living and nonliving entities continuously co-constitute one another through material exchange. From this standpoint, the movement of synthetic hormones across species and environments becomes less a sign of contamination and more a reminder of shared vulnerability—an indication that all bodies participate in and are shaped by the same chemical circulations.

This relational understanding is further sharpened by Mel Chen's argument about the animacy of matter. Synthetic hormones, in their view, are not inert materials but agents that carry economic, affective, and political charge. Their uneven movement across landscapes exposes profound inequalities in chemical exposure. Communities lacking robust water treatment facilities, or whose environments are already burdened by industrial waste, experience endocrine disruption more acutely. At a different but related scale, trans communities confront their own uneven exposures: inconsistent pharmaceutical quality, discriminatory access regulations, and heightened environmental precarity. These parallels reveal how chemical risk follows the contours of existing social hierarchies.

These patterns of exposure underscore that the circulation of synthetic hormones is not purely biochemical but is shaped by the infrastructures that manufacture, distribute, regulate, and dispose of them. Pharmaceutical production, agricultural practice, environmental policy, and medical governance collectively determine where hormones travel and whose environments or bodies they transform. The same systems that ensure stable access to oestradiol for some also generate toxic accumulations that disproportionately affect marginalised communities. Attending to this entanglement shifts the conversation away from fantasies of a natural order toward questions of accountability, redistribution, and care.

Metabolic design reframes this shift by foregrounding calibration rather than mastery—the continual adjustments that sustain liveability in systems marked by excess. The logic of hormonal routine, where dosage and timing are tuned in response to subtle feedback, mirrors the micro-adjustments ecosystems make when confronted with chemical loads beyond their capacity. Neither a trans body nor the environment can return to a pre-transition or imagined pre-industrial state, because both are shaped by histories that unsettle any idea of an original or proper form. Resilience therefore emerges from acknowledging, not denying, these entanglements with synthetic materials. In this sense, routine becomes a shared practice of survival, linking bodily maintenance to ecological adaptation through a shared language of recalibration.

From this perspective, pollution becomes more than a marker of harm. It is a record of relation, documenting how human invention permeates ecological systems and how design migrates beyond the sites of its intended application. The challenge is not to dream of a world purged of synthetic hormones—an impossible and arguably undesirable aspiration—but to cultivate more equitable modes of inhabiting chemical modernity. Hormonal ecologies remind us that shared exposure is the starting point for imagining environmental care that does not rely on natural orders, panic, or exclusion, but on collective responsibility and adaptive resilience.

Media Ecologies: Visibility, Exposure, and Digital Harm

The circulation of hormones does not end at the molecular level. It continues in the informational environments through which people learn to use them, interpret their effects, and navigate the systems that shape their availability. Contemporary trans life is deeply entangled with digital infrastructures that organise access to knowledge, structure visibility, and mediate everyday strategies of survival. Within these environments, trans communities assemble extensive repositories of practical insight: instructions for safer injection, syntheses of clinical research, dosage comparisons, and emotional support exchanged across borders. Online platforms operate as laboratories of collective expertise—another scale at which hormonal life is designed and sustained, where knowledge emerges through conversation, experimentation, and mutual aid rather than through institutional channels alone.

The generativity of these spaces exists alongside their precarity. Platform architectures filter what becomes visible, which narratives circulate, and which expressions are suppressed, often according to opaque algorithmic logics. As Taina Bucher notes, platform visibility is never neutral but conditioned by economic and political imperatives. For many trans users, this results in posts about hormones or anatomy being misclassified as explicit content, while sensationalised or pathologising representations surface readily. This dynamic echoes clinical gatekeeping, where recognition or access hinges on conformity to categories that systems deem legible or safe. Digital infrastructures thus re-enact the same pressures toward institutional legibility that shape medical transition, but at a different scale and through different mechanisms.

Healthcare data systems mirror these dynamics. Electronic health records, diagnostic codes, and insurance classifications organise trans people as datasets to be validated or constrained. Securing care often requires disclosing intimate details that systems can process, making visibility a condition for access and exposure a prerequisite for recognition. This administrative demand repeats, in bureaucratic form, the same tensions faced in digital environments: the need to appear in order to be acknowledged, and the risk inherent in every such appearance.

Within these tightly managed environments, everyday digital life is shaped by forms of harm that extend far beyond the screen. Harassment, targeted disinformation, and algorithmic erasure are routine experiences for many trans women online. Automated moderation frequently fails to distinguish between hateful content and the self-descriptive language trans people use about their own bodies, leading to the removal of supportive or informative posts while hostile material persists. These failures replicate structures of violence encountered in medical, legal, and social settings, demonstrating how digital architectures participate in the same inequities that structure hormonal, ecological, and institutional life.

Even under these conditions, trans communities cultivate strategies that counter digital precarity. Pseudonyms, encrypted messaging, private servers, and coded vocabulary allow individuals to modulate visibility and maintain safety. Such practices form routines of resistance that echo the rhythms of hormonal calibration: iterative, responsive, and oriented toward continuity rather than resolution. Jessa Lingel names these tactics infrastructural resistance—the creative reworking of digital tools to support autonomy, intimacy, and community care. In this context, opacity becomes a deliberate design choice: a way of sustaining relations without surrendering to the demand for complete transparency.

Alongside these protective strategies, digital spaces support a culture of community-led research that blurs the boundary between anecdote and evidence. Forums, Discord servers, and decentralised archives function as distributed laboratories in which embodied experience is translated into collective knowledge. Participants compare dosage adjustments, track shifts in sleep or libido, share injection techniques, log side effects, and interpret lab results together. These exchanges constitute a form of digital empiricism grounded in repetition and attention—another expression of the metabolic design that shapes hormonal routine, ecological calibration, and communal care.

The parallels between hormonal and digital calibration become evident here. Both require reading signals, adjusting to feedback, and managing thresholds of exposure within infrastructures that are uneven and often hostile. Both unfold within turbulent ecosystems that demand ongoing attunement rather than mastery. And both reveal that design, in these contexts, lies in the negotiation of vulnerability and relation: the continual work of sustaining life within systems that were not built to accommodate it.

Coda: Transition as Metabolic Design

Transition does not unfold as a linear passage from one state to another, but as an ongoing negotiation among chemistry, embodiment, infrastructure, and world. It is a design process without final form, defined by its capacity to sustain coherence through change. Each act of hormonal care participates in this process, not as a discrete intervention but as part of a continuous choreography of responsiveness. Design here is oriented not toward novelty, but toward endurance: the effort to hold together systems that are perpetually in flux.

Across this essay, design appears on multiple scales. As a discipline, it structures the tools, protocols, and categories that govern hormonal care. As a distributed practice, it emerges through the adaptive strategies of trans communities who reinterpret, refine, or circumvent those systems. As a material condition, it describes how bodies and chemicals co-compose in ways that exceed human planning. Transition gathers these scales into a single metabolism, showing that design is not external to life but immanent to its processes.

The multiscalar character of hormonal care becomes especially visible when viewed through the flows it activates. Transition recalibrates the body, yet it also reconfigures the infrastructures that attempt to contain it—from clinical protocols and administrative systems to pharmaceutical supply chains and digital platforms. These transformations extend outward into the wider ecologies through which synthetic hormones and other endocrine-active compounds circulate, joining planetary chemical currents that shape more-than-human forms of life. Hormonal care thus participates in metabolic processes that operate across tissues, institutions, and environments, revealing that the labour of transition is at once intimate and infrastructural.

The ethics that emerge from metabolic design recognise that liveability depends not on predetermined transformation, but on continual adjustment within the very structures that define the limits of the possible. Hormonal bodies, like those of trans women or ecological systems, respond to excess through calibration rather than by conforming to an idealised state. They model strategies for resilience grounded in responsiveness, patience, and relation. To live hormonally is to acknowledge interdependence: every micro-adjustment of dosage participates in global circuits of labour, waste, and care.

Naming HRT as design also clarifies its political stakes. Hormonal care mitigates not only dysphoria but the systemic harms produced by transmisogyny, administrative violence, and exclusion from healthcare. Each dose becomes a molecular assertion of the right to exist—a refusal to accept the conditions that render trans life precarious. Seen in this light, harm reduction becomes central to metabolic design: a practice that sustains continuity and possibility within environments that actively undermine both.

Transition therefore offers a model for living in a world defined by instability. It demonstrates how coherence can be created from flux, and how identity and relation can persist without relying on fixed endpoints. The hormonal body embodies a practice of design that is iterative, relational, and attuned to the vulnerabilities of its context. To transition is to engage design as a mode of living—to cultivate forms of care that recognise complexity without demanding mastery. Metabolic design names this orientation: a practice that treats every chemical, social, and ecological bond as both a material constraint and an occasion for creativity.

Ultimately, transition is not an exception but an embodied practice in which design, care, and matter interweave across bodily, infrastructural, and ecological scales to articulate the architectures through which individual and collective worlds endure.

BIO

Ro Pérez Gayo is a designer, researcher, and educator whose work explores the political, affective, and relational dimensions of design within infrastructures, technologies, and systems of governance. Her practice involves developing situated methodologies rooted in partial knowledge, affective attunement, and collective accountability. She approaches design as a means to unsettle prevailing conditions of what is thinkable and livable, seeking to reroute power and imagine otherwise. In doing so, she affirms design as a vital political and ethical practice of transformation.

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The Intangible made tangible: Monitoring the 'Invisible Threat'

An interview with Marian-Emanuel Ionaşcu, Fabio Salvadori and Federico Santarini

As part of this year's iteration of the ongoing Young Matters multidisciplinary project, Air Quality, The Sensing Unit transforms abstract air quality data into a tangible public experience, allowing us to see air pollutants and better understand how they impact the quality of our air and lives.

Bridging the fields of environmental engineering, data science, and critical design, research engineers Marian-Emanuel Ionașcu and Sebastian Petruc worked with R_73 designers Fabio Salvadori and Federico Santarini to visualise data on air quality. Through animated visualisations, on-site installations and urban billboards, the project moves beyond standardised charts to reveal the emotional, spatial, and bodily impact of the air we breathe.

For the first iteration of this public experiment, devices were installed in three key locations in Timișoara identified by the creators: The FABER headquarters, Timișoara City Hall, and the Polytechnic University campus.

Here, the project's creators explore the technical hurdles, design strategies, and public potential of this speculative work, which aims not just to inform, but to engage and empower its viewers by visualising the many pollutants present in the air we breathe.

How would you describe the exhibition to someone who has not yet experienced it?

MARIAN-EMANUEL IONAȘCU
Our project is designed to visualise air pollution in your area, at any moment of the day. The core idea is to make pollution visible, help people understand the associated risks, and empower them to take informed actions based on that data.

And designers, Fabio and Federico, what was your starting point for creating a visual language that could bring air quality data to life?

FABIO SALVADORI
For us, the starting point was noticing that this type of data is always locked away on a city's web portal and is never really experienced by the broader public.

FEDERICO SANTARINI
As information designers, that was the gap that interested us—making this data available and tangible within the urban environment itself.

The project description talks about air quality data as having an emotional, spatial, and experiential element. Marian, why is it important to move beyond traditional, standardised data presentations?

MI Across Europe, we monitor air pollution using fixed stations. While they provide accurate data, they lack spatial and temporal resolution. One station cannot represent the air quality from one street to the next, and they are often placed far from where people actually gather, like parks or malls. So, the data isn't truly relevant to our daily lives. Emotionally, this data is often just numbers and colours—usually just green or red—that aren't easily understandable. Not many people can distinguish the health implications between yellow, orange, or red, and this isn't well presented to a broader audience.

Fabio and Federico, how did you then go about representing this data in a way that would answer the concerns Marian highlighted and show these emotional and spatial sides?

FABIO S We decided on a more verbal approach than a purely numeric one. Instead of just representing a number with a graphic, we gave written messages about the effects of that specific pollution level on people with particular health conditions. This allows the data to be received at a much more actionable level for the public.

FEDERICO S Beyond the text, we created several different kinds of visualisations—2D representations, 3D environments, colour, and text—represented in the environment of the city.

We used geolocated data to create a 3D environment showing the city and its air quality at each point. The emotional part, in my interpretation, comes from the fact that the project allows individuals to understand the air quality around their body. With Marian's technology, it becomes a human-centric approach, not a sensor-centric one. It becomes about you, not just the city.

What were the biggest technical challenges in developing a real-time air quality monitoring system for public spaces?

MI The biggest challenge, for us and the entire research community, is the accuracy of the sensors. To create affordable, widespread devices, we must use low-cost sensors, which are known for lower accuracy and selectivity. The calibration—making these sensors show reference-grade measurements that correlate with the real phenomena—was our biggest hurdle. We tackled this through collaborations, like with the Norwegian Institute for Air Research, and by employing machine learning algorithms to correct the data.

And from a technical standpoint, does your "speculative approach" mean developing prototypes for future tech, or using current technology in new ways?

MI Both. We started by integrating all the current state-of-the-art technology. But we hit points where we needed to develop our own circuit boards to pinpoint specific errors. So now, we are more in the research phase, trying to find gaps in current implementations to step further in the development of these devices and increase user confidence.

This sounds like something that could become very real. With patents pending, do you see this as a widely available product or something that stays in the realm of theory and exhibition?

MI My initial goal was always to pinpoint pollution around an individual and to develop devices that can be sold commercially. We hit a wall with user confidence, which led us into deeper research. The pending patent is for a broader solution that incorporates fixed, mobile, and wearable devices. We are actively working towards this goal, with initiatives to install our devices long-term and even place them on city buses. So yes, our idea is for individuals or businesses to be able to see the pollution anywhere we go in the city with high enough confidence.

The work unfolds across animated visualisations, on-site installations, and a video on a billboard. How did you develop a visual language that works across all these mediums?

FEDERICO S Our starting point was the Air Quality Index (AQI), an internationally recognised standard with specific rules about substances and corresponding colours. We used that as a foundation to keep everything consistent, so there's a common index you can use to read all the visualisations.

FABIO S From a conceptual point of view, what tied everything together was visualizing the pollutant particles themselves—this "zoom-in" approach. We weren't just visualising the air as a mass, but the various pollutants that contribute to its measurement. This created a visual connection between the different pieces, even though they were situated in very different spaces.

FEDERICO S We wanted to make pollution tangible. If we knew there were, say, 500 particles of nitrogen dioxide in the air, we represented 500 particles. We wanted to materialise and bring to life what appears as just a single number.

Federico, with your background in data geography and cartography, how did you map something as intangible as atmospheric pollution?

FEDERICO S We took advantage of Marian's wearable devices. We thought it was interesting to use them to map the city and give a specific image of it at a specific time. We had students collaborate with us to do live monitoring by walking, which connected directly to the visualisation and the possibility to analyse the city through it.

The animated visualisation aims to show pollutants in a single breath. As designers, how did you create a visual metaphor for something so intimate and connected to the body?

FABIO S We made calculations to connect the Air Quality Index to what you breathe in a single breath. By making these connections in the city within a 3D space, we created a very located visualisation. Our animation also incorporates the variable of time, allowing us to use techniques akin to a short documentary to maximise the viewer's experience.

Marian, this collaboration seems unique, bridging environmental tech with visualisation design. To what extent did working with Fabio and Federico influence your current and future products?

MI I saw the collaboration as a unique opportunity. In recent years, we've been trying to correlate air pollution with cognitive functions or health, working with psychologists and medics. A constant issue is that the public doesn't understand the data. Our current app wasn't designed to be understandable by the average person. This project is a chance to change that. The engagement from students was huge, and they prefer this visual approach. I hope we can continue working together to move our applications a step further.

Fabio and Federico, what was your perspective on the collaboration? Did you learn anything surprising about air quality data?

FABIO S For us, it's always really nice to work with real data and innovative research. That doesn't always happen in the artistic and design world.

FEDERICO S And also to work with the people who created it. Often, you just receive a pack of data and that's it. Here, we had interaction with the people and procedures behind it, which was invaluable.

Finally, Marian, how do you feel the public could benefit from your plans for releasing air monitors commercially?

MI Air pollution is an invisible threat, and we often discover health issues related to it too late. I would like to see more wearable initiatives in the future. I am looking forward to continuing this project and trying to standardise devices, with the goal of creating a wearable device, perhaps for your wrist, to ensure people have these mappings and can make informed decisions on the air quality in their area.

7

Reflections

7.1

Brenntag: Bridging Europe's Green Ambitions and Local Challenges

Marian Ignat
Patricia Cârtog

Brenntag is a company focused on distribution and logistics of chemical components with a history of 151 years globally and 25 years of operations in Romania. Its journey in the green transition reflects the obstacles that the chemical industry faces in committing to the European green policies, even when a company intends to do so.

To understand their process, we started from the people working in it. Raluca Pintea has dedicated 17 years to Brenntag; at the moment, she is responsible for coordinating quality, health, safety, and environmental standards (HSE) across the company's operations in Central and Eastern Europe. She has witnessed its gradual shift toward sustainability and its alignment with European Union regulations.

The heavy industry must go green

"The change came with the European Union's Green Deal," Pintea explained to us. They tried to introduce a range of green products even before, 12 years ago, but the project failed because the market was not ready to pay more for a green premium product.

The European Union adopted the European Green Deal six years ago, setting out a number of important milestones and constraints for a circular economy. The Green Deal is the overarching framework, but chemicals are targeted by specific EU policies. For Romanian operators, however, implementation is inconsistent. "Imagine an economic operator who must comply with at least seven major legislative packages at the same time", Pintea highlights. The problem is not just the rules themselves, but the way Romania implements EU regulations, adding extra burden, creating chaos and extra costs." At the same time, industrial producers in Romania have been aware since 2007 that they must reduce their emissions under the European Union Taxonomy for Sustainable Activities (EU ETS system) – a classification system that defines what counts as environmentally sustainable economic activity. Currently, they benefit from free carbon certificates for the emissions they generate through the EU ETS system, but starting in 2026, the number of certificates will be gradually reduced until 2034, which means that polluters will pay for all emissions generated, thus making it more expensive to produce using the same polluting technologies.

Despite its good intention, the European Green Deal has its critics. Some scientists argue that the EU attention has been too much on "the objectives" that address the consequences without considering the real causes of climate change. In the EU's Green Deal, the principal objective with regard to chemicals appears to be the attainment of zero pollution which of course is quite impossible.

Industrial emissions are harder to abate because of process-related CO2. There are two types of emission sources – energy-related emissions (burning fossil fuels to provide the heat and energy needed for high-temperature industrial processes) and process emissions (inherent to the production process). Although Romania has shifted somewhat away from industry since 1990, the industrial base is both economically important and highly carbon intensive. The chemical industry accounted for 25.1 million tons of CO_2 emissions four years ago in Romania. In comparison, Romania's transport sector accounted for approximately 19 million tons of CO2 emissions in the same year.

Chemicals Strategy for Sustainability is a part of the European Green Deal adopted five years ago to encourage sustainable alternatives and to improve the assessment and management of chemical risks. It restricts the use of harmful substances, makes imports more closely monitored, and pushes companies to sell cleaner, more sustainable products. For Brenntag, this means checking its supply chains more carefully, cutting emissions from transport and warehouses, and helping customers switch to safer alternatives.

"The Green Deal comes and says – we, the European Union, are committed to moving away from fossil fuels", Pintea says, "but we currently have neither the infrastructure, nor the full production capacity or the vision to reach the point where we will be self-sufficient".

A crucial element in the process of supporting the decarbonisation of energy-intensive industries is the modernisation and expansion of electricity transmission and distribution networks – the development of CO2 infrastructure and hydrogen infrastructure. CO2 infrastructure is essential for the chemical industry, which will also rely on Carbon Capture and Storage (CCS) technology to reduce its process emissions. CCS is a process that prevents carbon dioxide from large industrial emitters and power plants from entering the atmosphere by separating it, transporting it via pipelines or ships and storing it permanently deep underground in geological formations.

Moreover, the "Fit for 55 package" is a set of proposals by the European Commission aiming to reduce greenhouse gas emissions by 55% by 2030 and achieve climate neutrality by 2050, as mandated by the European Climate Law. This package includes revisions to existing laws and new initiatives across various sectors.

The European Union does not offer significant dedicated national funding streams for implementing green changes. European funds are essential, but limited. In fact, a large part of state aid schemes are financed from European funds. Therefore, most of the financial support for industry is granted through each state aid. "Fiscally more restrained countries, such as Romania, risk being outpaced by the generous industrial support schemes implemented in countries like Germany and France and thus falling behind in terms of the pace and scale of industrial decarbonisation", Luciana Miu writes, an expert in industrial decarbonisation and building energy efficiency.

There are a number of uncertainties when it comes to financing this transition and practical implementation methods. Despite the constrained public finances, Romania has access to the Modernisation Fund and the Innovation Fund – a powerful EU funding stream. If used wisely, these funds could be paired with targeted state aid to support competitive industries, while also unlocking private investment. Another untapped lever is green public procurement – the process through which public authorities seek to purchase works, goods, or services that have a low environmental impact throughout their entire life cycle. Economists say that it is a more effective alternative for supporting industry in the green transition process, with a more limited impact on the national budget. By implementing a functional green public procurement system, Romanian industry would benefit from predictability and support in the decarbonization process, thus maintaining its competitiveness at European and global level.

As a lower-income EU member, Romania is also eligible for additional support through mechanisms like the Cohesion Fund — that supports investments in the field of environment for countries with a gross national income per capita below 90% EU-27 average. Moreover, Romania is geographically well-positioned for the green transition. It holds significant potential in renewable energy, green hydrogen and even onshore CO_2 storage. If it can align its strategy with its resources, Romania could shift from laggard to leader in Europe's industrial decarbonisation push.

Time, however, is not on our side. Accessing and deploying EU funds quickly will be crucial, and a clear national industrial strategy is needed to prioritise this. At the end of 2023, the Romanian Government published the long-awaited Romanian Industrial Strategy 2023-2027 promised in the governing coalition's program two years ago. The publication of this strategy is an important step in establishing an institutional framework capable of managing the multiple and intersecting challenges facing Romanian industry. However, it raises more questions than it answers in terms of addressing these challenges.

Brenntag: Local Realities

Brenntag is a German-headquartered multinational and DAX40-listed company, therefore it is supposed to align with global sustainability standards. Its Romanian operations are centered in Chiajna near Bucharest and their model illustrates the tension between global sustainability commitments and local constraints.

One of Brenntag's biggest obstacles is convincing clients to adopt greener – but more expensive – alternatives. Higher prices for sustainable products are a more pressing issue in Romania than in other EU countries, as lower disposable incomes push consumer preferences toward the cheapest products, and companies respond by choosing the least expensive raw materials. "We have solvents that are natural, based on lactic acid, instead of the classic toxic ones used in paints and coatings", Pintea explains. Furthermore, companies must pay twice for the legal disposal of chemical packaging waste: once through the Environmental Fund tax, and again through the actual disposal process, which can only be legally carried out by sending the waste to landfills.

"But the price difference is from one euro per kilo to three. In a cost-driven market like Romania, producers simply cannot accept that." While Nordic and Western European customers are more willing to pay the premium, Romanian manufacturers remain reluctant.

Brenntag has woven sustainability into many aspects of its Romanian operations, guided by ISO 26000 standards for social responsibility. The company screens its suppliers, requiring minimum social and environmental standards, SEDEX membership (Supplier Ethical Data Exchange), and regular audits. It engages with the community through partnerships with NGOs like Plantăm Fapte Bune for tree planting, sponsorship of education and sports initiatives, and a preference for sourcing from local suppliers.

Brenntag relies on outsourced logistics rather than a proprietary truck fleet, enabling optimsed routes and fewer empty returns, and it is gradually increasing intermodal transport, though Romania's weak rail infrastructure remains a constraint. "In Romania it's almost impossible", Pintea says. "We do not have a functional rail freight transport system. We do not have a system to put containers on trains, we do not have mechanisms to return empty containers. So we try to make intermodal transport work, but almost everything stops at the border."

At its Chiajna site, the company invested in new roofing, rainwater collection for irrigation, composting, and upcoming solar panels, they claim.

When it comes to carbon emissions

accounting, Brenntag developed its own application that is also TÜV certified – a trademark meaning that a product, service, or process has been tested and verified to meet specific safety, quality, and sustainability standards by a Technical Inspection Association. Clients can purchase access to this platform and calculate the carbon emissions associated with the products they buy from the company, independently and in real time. There is a vast amount of information behind it – Brenntag relies on data provided directly by their suppliers or estimations, if the suppliers do not provide their data.

In terms of packaging, Brenntag sells most of its products in returnable packaging. They issue a separate invoice for the package and the clients have 30 days to return it. If they return it within that period and in good condition, the company returns the money for the packaging. This system allows them to avoid putting large volumes of plastic packaging into circulation that would otherwise remain in the market.

The bigger picture – Romania's struggles

In Romania, systemic barriers hinder the adoption of greener solutions. We face outdated railway infrastructure that limits intermodal transport and regulatory incoherence. The market remains heavily price-driven, preventing companies from absorbing the higher costs of sustainable alternatives such as lactic-acid-based solvents, which are three times more expensive than conventional ones. Public procurement rules further entrench this problem, as the "lowest price wins" criterion blocks the uptake of sustainable options even in critical sectors like water treatment, where mercury-free flocculants could be used. At the same time, universities continue to focus on traditional oil-based chemistry, neglecting areas like green chemistry, chemical recycling, or hydrogen, and the absence of state incentives or subsidy schemes leaves little room for modernization or innovation.

Romchimica, the Romanian Chemical Companies Association, set up a report last year on the Transition Pathways of Chemical Industry towards Green Economy and Digitalization. There are a number of strategies being pursued to reduce the negative impact on the environment, several: replacing fossil energy with renewable energy, increasing efficiency in energy and raw material consumption, substituting fossil-based, polluting, or energy-intensive raw materials and intermediates with more sustainable alternatives, reusing and recycling products at the end of their life cycle, and improving logistics through shorter distances and less polluting transport methods. In order to do that, the Romanian chemical industry must become more resilient. The industry needs support from the government, as the responsibility can not fall only on companies and the chemical sector. This is a shared objective.

The report suggests that the Romanian state should create a framework that encourages research and development within existing companies, improves communication, technology transfer, and opportunities to showcase new technologies both domestically and abroad, supports the industry in developing and producing new or improved technologies locally, and attracts investors capable of creating markets for Romanian companies.

What's next?

In July 2025, the European Commission presented a plan to rescue, modernise, and reinforce the EU's chemical industry, which is currently facing severe challenges. High energy prices, increasing global competition—particularly from China and the United States—and declining production in Europe have put the sector under significant pressure. The plan is structured around several key directions:

PROTECTION AND RESILIENCE
The EU will establish a Critical Chemicals Alliance to reduce dependency on risky imports and to secure Europe's supply chains. This measure is aimed at ensuring that essential chemicals remain available within the Union and that strategic industries are not exposed to vulnerabilities from external suppliers.

AFFORDABLE AND GREEN ENERGY
The plan promotes affordable natural gas, low-carbon hydrogen, carbon capture and storage, and increased use of renewable resources.

INNOVATION AND SUSTAINABLE PRODUCTS
The plan includes incentives and funding to foster the substitution of polluting substances with cleaner, safer alternatives. Investment will be directed toward developing "green chemicals" and advancing recycling technologies, especially chemical recycling. This will not only drive sustainability but also create new markets for environmentally friendly products.

SIMPLIFIED REGULATION
The EU recognises that the current regulatory framework can be excessively burdensome. The plan therefore proposes to streamline requirements for labeling, cosmetics, fertilisers, and related sectors.

7.2

Chimcomplex has resisted regime change and proved its success. Can it hold up during the green transition too?

Marian Ignat
Patricia Cârtog

Chimcomplex is known in Romania for being one of the biggest chemical players at the national level, operating two industrial platforms in Onești and Râmnicu Vâlcea. Founded in 1954, the company has more history during communism than outside of it. Its very existence today is an accomplishment as many factories closed shortly after the fall of the regime.

But now a new change is threatening the life of many industrial actors: the green transition and the harsh geopolitical forces shaping the race towards competitiveness. Chimcomplex is no exception, traversing periods of both exponential growth and loss, but remaining an important company in the field.

However, the journey is not yet done. European policies are in constant change, energy prices are still high, and demand for low-carbon products pressing. How is this company holding up and navigating these challenges and what is their story telling us about the bigger picture of industrial transformation during the climate crisis?

Becoming a powerhouse

Chimcomplex's original beginning started as Borzești Chemical Plant on the Borzești Industrial Platform, a project that changed the face of the back-then village Onești, into an important industrial city dubbed in the 1960s 'the citadel of Romanian petrochemistry'. The emergence of the platform was connected to the opening of an oil refinery, but its activities span beyond that, including facilities for rubber and chemical processes that first produced chlorine, sodium hydroxide and hydrogen gas.

The Chemical Plant is just one of the facilities of the platform, along with a thermal power plant, a refinery and a rubber plant, all well connected to the region. The salt, a component that to this day powers the chemical plant, came from the Târgu Ocna Salt Mine, methane gas from Mediaș, water from the Valea Uzului reservoir, and thermal energy from the Borzești thermal power plant.

Not long after its opening, in 1966, on the other side of the country, another industrial complex was constructed in Râmnicu Vâlcea - Oltchim. Both platforms were producing chlorosodic, oxo alcohols, vinyl chloride (VCM), polyvinyl chloride (PVC), and HCH lindane, used in key industries such as: construction (for pipes and wires), pharmaceutics, agriculture (insecticides) and others.

Immediately after the fall of communism, the Borzești Chemical Plant became Chimcomplex, primarily with public capital, and in 2003 it went fully private, saving it from bankruptcy. Oltchim was later on partly bought by Chimcomplex after a few years of insolvency, linking Onești and Râmnicu Vâlcea as two of the facilities of the company and becoming thus a powerful industrial player in Romania in the chemical sector.

The cost of producing

The effort to keep Chimcomplex alive has cost a lot of money. In the first ten years, over 300 million euros were invested in the development of the company and its facilities. Then, in 2018, 168 million euros were used to buy Oltchim's stocks, just to mention two figures. At this scale of business, nothing out of the ordinary. But money isn't the only cost one should look at. Every economic activity has an environmental impact and Chimcomplex is no exception.

Industry has been for decades one of the major polluters in Romania. In 1990, it accounted for almost 38% of the national emissions, releasing into the air 84,146 Kt CO_2 equivalent (equal to 19.2 years of emissions of civil aviation in France, in nowadays terms).

This has drastically changed over the course of years. Since 2005, the EU has installed a system of limitations for certain installations and operators, such as heat and electricity generation or aviation. Additionally, there is also a market for companies to trade emissions allowances, between those who exceed the cap and those who decarbonise.

Industrial manufacturing is included in this scheme, called EU Trading System - ETS in short. In 2022, Romania accounted for 28,200 Kt CO_2 equivalent in this sector, almost three times less than in 1990. Still, in relative terms, industry equals to 26% of national greenhouse gas (GHG) emissions. Chimcomplex falls under the system and, in its first publicly available sustainability report, declared emitting approximately 464 Kt CO_2 equivalent in 2022.

Holistically, this means they are responsible for 3.8% of emissions at the sectoral level and 0.43% at national level. Might look insignificant, but it isn't. One single company has the footprint of a city with a population of 58,000 people, like Reșița or Călărași. And most of it comes from its energy consumption.

Energy transformation

Long before the European Green Deal came into place in 2019, Chimcomplex started its energy transition, mostly driven by economic reasons, due to high energy bills. In 2006, they accounted for approximately 33% of total production costs and approximately 46% of total operating costs.

Thus, in 2008, the company invested in a cogeneration plant, that produces both electricity and useful heat at the same time. A study from 2014 showed that the new installed system had 'a positive impact on the environment, consisting in a 28.8% reduction of the direct and induced CO2 emissions'. While electricity production increased, it is worth noting that gas consumption also increased.

Chimcomplex continued to invest in co-generation. If in 2015 had an energy capacity of 7.6 MW, this year they're planning to reach a capacity of 108 MW, with the support of the European Union. They're producing so much, covering the majority of their internal needs, that they're also selling it to consumers. The thermal power, of minimum capacity of 89 MW, is planned to be connected to the district heating network of Râmnicu Vâlcea.

New technology, same issues

While co-generation plants powered by fossil gas bring flexibility to the grid, being way more easily detachable than nuclear, and less dependent on weather like renewables, they also raise a series of problems.

One is related to methane emissions, which are 80 times more potent in warming the atmosphere than CO2, in the first 20 years. Chimcomplex enjoys institutional support, the development of gas infrastructure being a primary strategy for decarbonisation. At the same time, decision-makers ignore that Romania has signed the Global Methane Pledge, which supports a reduction of global methane emissions of at least 30 percent from 2020 levels by 2030.

Another issue is related to costs. Gas prices are still very high in Europe and the resources are not so abundant. In 2022, when Russia invaded Ukraine and the continent was struggling with an energy crisis, Chimcomplex was also under pressure and they eventually fired 400 employees.

When used to produce electricity, gas drives the prices up considerably higher than those set by renewables. And consumers have to pay the bill, because of the merit-order system in which every electricity producer receives the price of the last bidder, the most expensive one.

Moving forward

Chimcomplex's latest sustainability report from 2024 shows a sad reality of the industry: while Paris Agreement was signed in 2015 and the European Green Deal introduced at the end of 2019, the company declared that they 'do not yet have a transition plan in place to address the challenges related to climate change, in line with the climate neutrality goals'.

The national political reality might explain why this is the case. Constantin Rudnițchi of RFI reported last year that Romania doesn't have one industrial strategy, but two. In 2023 the government published the strategic document for 2023-2027, but hardly introduced any incentives or conditionalities for industrial companies to adopt top-notch, less polluting technologies. Then, a year later, the government published a new strategy, this time with a longer time span from 2024-2030, and including a set of benefits for developing industry, such as tax cuts, fastened approval procedures and a dedicated budget.

But this lack of clarity and stability in governmental plans goes beyond national borders. The EU has been on a crusade of deregulation in the past months and continues to extend it even today. While companies like Chimcomplex were just starting to adjust to the requirements of the Corporate Sustainability Reporting Directive (CSRD), for example, the regulation has been reduced in scope. Chimcomplex might still be subjected to it, as it has over 1000 employees, but 85% of the initially targeted companies will not. Moreover, the Commission even proposed the removal of adopting and implementing a transition plan for climate change mitigation.

But the climate crisis disregards policy

Whether Chimcomplex will implement a net zero plan does not change the fact that climate change will impact the chemical sector. A presentation by Lux Research points out that 'extreme events will only grow more frequent as global average temperatures continue to rise' and this will continue to disrupt the chemical production and distribution as extreme storm events, temperature change, and drought will only continue to increase over the next 50 years. 'Serious impacts will include damage to capital assets, disruptions to transport and raw materials availability, and impacts on labour productivity and safety' add the authors.

The EU regulation was valuable in that sense because it obliged companies to identify its material sustainability impacts, risks and opportunities from a double perspective. On one hand, looking at how sustainability matters may pose either a prospective material risk or opportunity that could affect a company's financial performance and position over time. On the other hand, assess an "inside out" view on the actual or potential impacts on people or the environment that are directly linked to a company's operations and its value chain.

If Chimcomplex will continue to treat climate change and the green transition seriously, disregarding the change of attitude from Brussels, it might be able to adapt to potential disruptions and win the race to competitiveness. Other factors have to play in their favour too, such as financial support and market adaptation. While the journey is not easy, the transformation is inevitable.

An important piece in the chemical industry puzzle

Will Chimcomplex hold up? The answer weighs on the hundreds of workers that are, year by year, slowly laid-off. But also on the chemical industry overall. Nationally, 60% of the raw materials they use come from the local market and many of their products dominate the market share up to 90%. Globally, Chimcomplex's products are being exported to 60 countries across 5 continents. It feeds the local and global chemical industry and even sustains chemical processes that otherwise might find it hard to conduct business.

While the economy thrives on the idea of scarcity, losing a player like Chimcomplex will reverberate deep into the web of interactions that sustain the company and the industry daily.

Overcoming the challenging green transition will as well entail losses. Innovations and higher efficiency rates will push personnel out of the organisational chart. Markets adapted to green products will potentially mean sourcing from different, less polluting stakeholders. And the list goes on.

But the trade-off is worth it. Working on achieving a 'clean industry' is improving the life of workers and locals, decreases pollution, and helps reaching net zero targets, essential in the fight to mitigate the climate crisis.

And even more importantly, perhaps it will prove that even big industrial actors can flourish in this transition. Just in different ways: quality over quantity, recyclability and renewable power are just a few examples. The rest is yet to be told by companies just like Chimcomplex.

The Environmental Costs of Europe's Second-Largest Copper Mine

Marian Ignat
Patricia Cârtog

The Roșia Poieni mine is located in the Apuseni Mountains and contains Europe's second-largest copper deposit, with over one billion tonnes of ore grading 0.36% copper and traces of gold. The ore body, a porphyry deposit of chalcopyrite and pyrite, was discovered during the industrial push in the 1960s. Open-pit mining began in the 1970s, and since 2002 the state-owned company CupruMin has managed operations.

Today, around 550 people work on the site. Every day, the mine blasts through 14,000 tonnes of rock. The process begins with massive mills that crush the raw rock into fine dust. From there, the material is mixed with water and special reactives, preparing it for the next stage: flotation. In this foaming process, copper-rich particles rise to the surface, where they are collected. The procedure is repeated several times until the concentration reaches about 20 percent. What remains at the end is a mixture of water and tailings — the waste material left behind after extraction.

Since the 1980s, CupruMin has disposed of its waste in surrounding valleys. Villages paid the price: first Curmătura, then Geamăna, where more than 300 families were forced to leave. The Şesii Valley was transformed into a tailings impoundment now covering more than 220 hectares. Geamăna disappeared under rising toxic sludge.

What fills Valea Șesei is not inert waste but a slurry of crushed rock mixed with chemicals. When sulfides oxidise, they produce acid mine drainage — acidic waters carrying dissolved metals. CupruMin counters this by adding lime to neutralise acidity. Officially, the company stresses that the facility is stable, monitored daily, and compliant with EU waste management rules.

However, satellite data reveal land subsidence and slope instability in waste rock dumps, with movements of up to 200 millimetres per year. Vegetation indices show long-term decline around the mine.

For locals, the story is one of repeated contamination, barely documented. Hundreds of cubic meters of polluted water spilled into the Arieș River in 2004, with impacts recorded as far as Turda, 80 kilometers downstream. Thousands of dead fish floated in the Arieș after CupruMin failed to activate control systems in 2008. A burst pipe released hundreds of tonnes of mining waste into local rivers in 2011. And six thousand cubic meters of tailings escaped Valea Șesei due to corrosion in a long-abandoned pipe beneath the dam eight years ago. Each time, the company paid small fines — €2,500 in 2004, derisory compared to the scale of damage.

In 2012, Romania attempted to privatise CupruMin under International Monetary Fund pressure. The government chose Roman Copper, a Canadian vehicle with no mining experience, but negotiations collapsed when the company refused to post a €32 million environmental bond. Since then, privatization has stalled.

Meanwhile, the European Union has declared copper a strategic raw material, central to the green transition. The Critical Raw Materials Act contains targets for increased domestic mining, processing, and recycling by 2030. Yet Romania today mines copper but lacks a functioning smelter or refinery. Concentrates from Roșia Poieni are shipped abroad, while waste and liability stay at home.

CupruMin's management insists there is no pollution risk. Authorities rarely comment on accidents. Local associations struggle to amplify their warnings, while the image of Geamăna's drowned church has become a symbol of what is lost when mining's promises outweigh accountability.

In 2017, the European Court of Justice condemned Romania for failing to meet EU standards on waste. A decade later, the issues remain unresolved.

Europe demands more copper for electrification and renewable energy. Romania delivers the ore but absorbs the damage. Valea Șesei stands as both a cautionary tale and a test of whether mining in Europe can ever align with environmental justice.

CupruMin is also one of Romania's last major operating mines, while the country still holds significant mineral resources. Yet the lack of domestic capacity to process them responsibly leaves Europe relying on raw materials from Russia, China, and other authoritarian states. In effect, Europe has exported its environmental burdens abroad while deepening its dependency on unstable suppliers.

Mining will never be fully sustainable. At best, it can become less harmful through stricter waste management, cleaner technologies, and stronger community oversight. But we do need minerals, yet very few societies want to bear the scars of extracting them. The process is inherently harsh, no matter how many improvements are made. That is why Europe must also confront its own overconsumption, invest far more in recycling, and ensure that where mining does happen, it causes the least possible damage — even if achieving that is extraordinarily difficult.

8

Addendum

8.1

Learning Regimes and Capacity Formation in an Advanced Peripheral Economy: Romania’s Chemical Industry

Romania’s chemical industry

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This paper investigates how technological learning unfolds in the chemical industry of an advanced peripheral economy integrated into global value chains via foreign direct investment. Drawing on firm-level data, expert interviews, and sectoral mappings, it develops and applies a five-part typology of learning regimes based on firms' autonomy, governance structures, and knowledge access. The analysis shows that Romania's chemical sector has been reintegrated into the global economy primarily through execution-based and commercial relay functions, with capability accumulation concentrated in a small number of residual or task-based firms. Despite legacy infrastructure and skilled labour, the sector remains constrained by weak institutional intermediation, fragmented innovation systems, and limited spillover from foreign firms. Industrial policy has lacked selectivity and conditionality, reinforcing functional subordination rather than enabling upgrading. The paper contributes to debates on learning under dependent integration by offering a conceptual and empirical framework to distinguish symbolic, commercial, and productive knowledge regimes in advanced peripheral contexts.

Introduction

In semi-peripheral economies such as Romania, integration into global value chains (GVCs) has produced divergent learning and innovation outcomes across sectors. While industries like automotive have been able to attract significant foreign investment in both production and engineering services, establishing platforms for embedded R&D (Pavlínek, 2020; Jürgens & Krzywdzinski, 2009), other manufacturing domains, particularly the chemical and pharmaceutical sectors, remain structurally disconnected from such upgrading trajectories (Mihály 2023; Vissak, 2024). Despite hosting many transnational subsidiaries and participating in export-led growth (Ban, 2016; Bohle & Greskovits, 2012), Romania's chemical and pharmaceutical sectors struggled to internalise innovation capabilities or to build cumulative technological capacity. This divergence raises fundamental questions about the institutional and organizational foundations of learning: How do different firms and sectors in a peripheral industrial structure learn? Under what conditions do they accumulate capabilities? And what explains the persistent stagnation of certain industries despite formal inclusion in global and European knowledge frameworks?

A growing literature investigates how firms in developing and emerging economies build innovation capacity through global subcontracting, FDI, and public research collaboration. This scholarship has yielded typologies of learning and upgrading: captive execution via standardised routines (Pietrobelli & Rabellotti, 2011), task-based modularization with limited autonomy (Ernst & Kim, 2002), and residual innovation rooted in legacy knowledge and contextualised expertise (Navas-Alemán, 2011; Stojcic, 2024). Yet less is known about how these regimes manifest, co-exist, and evolve in advanced peripheral economies (May et al., 2024), countries integrated into global capitalism in ways that enable production expansion without necessarily fostering innovation upgrading. In such contexts, learning regimes are often constrained not only by global power asymmetries, but also by domestic institutional weaknesses, selective industrial policy, and fragile links between public research and industrial strategy.

This article argues that firm-level learning regimes in Romania's chemical and pharmaceutical industries shape capability accumulation and innovation involvement through mechanisms linked to global positioning, organizational governance, and national innovation systems. Leveraging on sector-specific data and narrative reconstructions, we show that firms operate within distinct and often stable learning regimes: SOP-based captive execution, residual learning rooted in socialist-era routines, subcontracted innovation, commercial relay systems, and interface regimes focused on branding and customer proximity. Each regime configures different forms of knowledge access, local autonomy, and innovation orientation, resulting in uneven sectoral dynamics and limited mobility between regimes.

Transitions between these regimes, e.g., from captive execution to autonomous innovation, are rare and conditioned by multiple interacting mechanisms. Positioning within the GVC affects firms' exposure to dynamic knowledge and learning opportunities (Gereffi et al., 2005; Dedrick & Kraemer, 2015; Butollo et al., 2024; Coveri et al., 2024), the governance of ownership and the nature of coordination across firm networks determine local autonomy in decision-making (Bulfone et al., 2022); and the density and directionality of ties with public research institutions shape absorptive capacity and the likelihood of spillover integration (Cohen & Levinthal, 1990). In Romania, the combination of high technological entry thresholds, weak institutional coordination, and underdeveloped sectoral research linkages has made such transitions particularly difficult, reinforcing a path-dependent equilibrium of low or marginal learning for much of the chemical industry.

To explore these dynamics, we develop a multi-method empirical strategy combining:

(1) reputational sampling of twenty firms with visible recognition in industrial chemical value chains;
(2) automated extraction and qualitative coding of over two decades of archival business news;
(3) historical series of financial performance; and
(4) citation network and co-authorship analysis of Romanian chemical research institutes using Web of Science data.

This allows us to reconstruct firm-level event histories related to technology transfer, licensing, research centre development, and modernization programs, and to map them onto a typology of learning regimes. By linking firm strategies to sectoral positioning and public-private research interactions, we offer a grounded framework for understanding not only what kind of learning occurs, but why certain firms remain locked in low-capability trajectories while others achieve partial upgrading.

The study contributes to three ongoing scholarly conversations. First, it deepens the theorization of learning regimes under dependent industrialization, building on frameworks that link value chain positioning to technological capacity formation (Pietrobelli & Staritz, 2018). Second, it clarifies the institutional and sectoral limits of transition between learning regimes, advancing the debate on upgrading traps and regime stickiness in peripheral settings (Chang et al., 2024). Third, it extends research on the heterogeneity of innovation paths within national systems of innovation by showing how policy voids, weak intermediation (Zylberberg, 2019), and institutional mismatches shape not only firm outcomes, but sectoral divergence. By focusing on a historically strategic industrial sector under socialism with significant investments (Medve-Bálint, 2024), the article invites broader reflection on the sectoral limits of technological sovereignty and the differentiated logics of learning in a semi-peripheral context.

Literature review

2.1 Learning in global value chains: modes, regimes, and firm-level capabilities

Innovation scholarship holds that firms do not passively receive knowledge but develop it through active engagement in processes of learning. Classic contributions have conceptualised learning as multifaceted, encompassing learning-by-doing, learning-by-using, learning-by-interacting, and learning-by-searching (Lundvall, 2011; Bell & Pavitt, 1993). These modalities differ in the degree of organizational routinization and absorptive capacity they require (Cohen & Levinthal, 1990; Macpherson & Holt, 2007; Bogers et al., 2018; Do et al., 2022). In sectors such as chemicals and pharmaceuticals, where production involves complex routines and high safety and quality standards, even learning-by-doing can entail significant cognitive load and tacit knowledge accumulation. However, not all learning leads to technological upgrading or innovation (Sampath & Vallejo, 2018). Firms may accumulate experience without improving their innovation capabilities, especially when confined to repetitive or standardised tasks within global production systems.

Rather than viewing learning as individual modes, scholars have proposed the concept of learning regimes, systemic combinations of organizational routines, governance structures, and institutional couplings that channel learning processes in particular directions. Chaminade et al. (2009) use the term to differentiate between the innovation environments of firms operating in different parts of the world economy. Similarly, Lee, Szapiro & Mao, (2018) argue that different configurations of learning opportunities and institutional supports shape distinct 'regimes' of catching-up or standstill. The regimes are not merely firm-level behaviours; they are embedded within structural positions in GVCs, conditioned by governance relations, and linked to the strength or weakness of national innovation systems. In this view, they are not freely chosen but emerge at the intersection of positional constraints and institutional affordances.

A key insight of this literature is that capability accumulation is not a linear or automatic outcome of participating in GVCs. Ariffin & Figueiredo (2006) show that latecomer firms often struggle to advance from basic operational learning to adaptive or innovative capabilities. Even when exposed to external knowledge, firms may fail to internalise and deploy it effectively without strong internal routines and supportive institutional environments. Firm-level learning is thus filtered by absorptive capacity, organizational structure, and access to problem-solving contexts. In many peripheral economies, firms are locked into low learning regimes where the scope of activity is constrained to execution, assembly, or distribution. In such cases, learning-by-doing does not translate into innovation, and global integration can reinforce dependence rather than capability development.

This study builds on existing perspectives by identifying five empirically grounded learning regimes in Romania's chemical and pharmaceutical industries. Each regime combines distinct modes of learning, governance structures, knowledge access, and degrees of technological autonomy. Crucially, these are not static categories, but historically situated configurations shaped by Romania's position in global production networks and the fragmented infrastructure of its national innovation system. By examining how firms are inserted into GVCs and how this affects their learning prospects, the paper advances a more nuanced understanding of technological upgrading in advanced peripheral contexts.

2.2 Governance, positioning, and the limits of technological upgrading

Understanding learning in global production networks requires attention not only to firm capabilities but also to how firms are governed within value chains. GVC scholarship has long emphasised that governance structures, ranging from market-based to modular, relational, captive, or hierarchical, condition both the scope of supplier autonomy and the depth of knowledge exchanged (Gereffi, Humphrey & Sturgeon, 2005; Arts et al., 2021). Captive governance restricts the technological discretion of firms, as lead firms control product design, process standards, and intellectual property. In this context, learning may be restricted to codified routines anchored in standard operating procedures, leaving little space for creative recombination or local experimentation. Even in relational or modular forms, the transfer of knowledge is often limited by power asymmetries and the strategic interests of lead firms (Pietrobelli & Rabellotti, 2011; Rotolo et al., 2022).

Geographical and functional positioning within GVCs further shapes learning opportunities. Firms located in peripheral or low-cost economies are frequently relegated to production or distribution functions, with limited access to upstream design or downstream market analytics (Morrison, Pietrobelli & Rabellotti, 2008). These structural constraints reduce the likelihood of upgrading beyond a certain technological threshold. For instance, Sturgeon and Zylberberg (2016) argue that while modularity facilitates the international dispersion of production, it simultaneously limits local innovation by 'black-boxing' core technologies. Moreover, positional disadvantages are reinforced when national innovation systems are weak, fragmented, or disconnected from firm-level needs (Lee, Szapiro & Pereira, 2018).

The challenge is especially acute in sectors like chemicals and pharmaceuticals, where innovation is capital-intensive, regulation-heavy, and IP-sensitive. In these industries, R&D tends to be concentrated in the global North, near corporate headquarters and elite research institutions. Studies on industrial upgrading show that functional movement into R&D or engineering roles is rare and depends on strong institutional scaffolding (Lee, 2024; Yeung & Liu, 2022). Without proactive policy, local firms risk falling into 'low learning traps' (Chaminade & Vang, 2008), performing routine tasks without acquiring design or innovation capacities. This is particularly problematic in advanced peripheral contexts, where middle-income countries possess export infrastructure and FDI inflows but lack the innovation ecosystems needed to convert GVC participation into sustained upgrading (May et al., 2024).

As a result, participation in global markets does not automatically yield technological spillovers or capacity accumulation. Even embedded foreign subsidiaries often maintain weak ties with local suppliers, research institutions, or policy frameworks (Lema, Rabellotti & Gehl Sampath, 2018). Sectoral characteristics and firm strategies play a critical role. Industries like automotive are more prone to decentralizing engineering due to modular production and rapid product cycles. In contrast, industrial chemistry centralizes R&D upstream, making peripheral innovation insertion structurally unlikely (Lema & Rabellotti, 2021). This article draws on these distinctions to explain why Romania's chemical industry has not mirrored the modest R&D expansion of its automotive counterpart, and why many firms remain locked into execution or distribution roles with limited transition potential.

2.3 Learning regimes, institutional contexts, and the possibility of transition

The concept of learning regimes provides a useful bridge between the firm-level dynamics of knowledge absorption and the broader institutional contexts in which firms operate. Drawing from evolutionary and institutionalist traditions, learning regimes refer to patterned configurations of how firms access, internalise, and accumulate knowledge, shaped by their position in value chains and embeddedness in national systems of innovation (Lorentzen, 2008; Lundvall, 2017). They vary in terms of the source of learning, experiential, imitative, codified, and in the scope of agency permitted to firms: from execution-based routines dictated by external actors to endogenous processes of experimentation and recombination. Understanding how these regimes emerge and evolve requires situating firms within the organizational field of inter-firm governance, public research systems, and policy frameworks.

In less-developed innovation systems, learning regimes tend to be residual, fragmented, or execution-based. Firms often operate with outdated routines, limited feedback from lead firms, and weak connections to research institutions. While some accumulate technical knowledge through reverse engineering or incremental process improvements, these capabilities rarely coalesce into innovation systems. Such firms may achieve 'stable reproduction' of legacy technologies but struggle to move toward design or product development (Figueiredo, 2014). Conversely, more advanced learning regimes, task-based, projectised, or hybrid, require tighter coupling between firms and public institutions, as well as strong absorptive capacities (Crescenzi & Gagliardi, 2018). Yet such transitions are not guaranteed. They depend on institutional plasticity, firm strategy, and often, a catalytic role played by industrial or innovation policy.

The possibility of transition between learning regimes, say, from captive execution to task-based co-development, hinges on multiple factors. First, firms must acquire sufficient internal capabilities to negotiate greater autonomy in their value chain roles. Second, public institutions must enable such transitions through targeted support: R&D subsidies, collabourative programs, or policy platforms that incentivise experimentation. Third, governance structures in GVCs must allow scope for upgrading. As shown by Lema and Rabellotti (2021), when lead firms retain strict control over IP, standards, and customer interfaces, peripheral suppliers are locked into routines with limited scope for progression. Even when firms develop capabilities, the absence of supportive institutions, technical universities, technology centres, or active innovation agencies, can stall transition.

In Romania, these dynamics are particularly stark. The early 2000s' privatization drive sidelined the chemical industry, while sectors such as automotive and metallurgy benefited from more strategic restructuring that averted large-scale industrial collapse (Mihály, 2023). As a result, the automotive sector has seen selective upgrading via engineering centres and digital integration, whereas the chemical industry remains fragmented and dominated by residual or execution-based regimes. As detailed in the empirical sections, Romanian chemical firms exhibit a range of learning configurations, from foreign-owned subsidiaries operating under SOPs to partially autonomous firms with limited innovation outputs. Yet few demonstrate the institutional or strategic preconditions for regime transition. The interplay of ownership structure, sectoral dynamics, and institutional grounding remains central to explaining this stagnation. The remainder of the paper examines these configurations empirically, advancing a typology of learning regimes and identifying the barriers to upgrading in Romania's chemical and pharmaceutical industries.

Method and data

The empirical analysis targets Romania's chemical and pharmaceutical industries, focusing on firms active between 2000 and 2025. Initial sampling used NACE codes linked to chemical production, pharmaceutical manufacturing, and chemical distribution. However, this classification produced noise, particularly from automotive conglomerates like Continental and Bosch. While these firms have chemical capacities (e.g., synthetic rubber, polymers), these are vertically integrated within automotive value chains, governed by priorities in electronics, tires, and mechanical systems, excluding them from the core chemical innovation ecosystem. As a result, the methodology shifted to a reputational and sector-specific approach. Using Ziarul Financiar rankings, industrial association documents, and expert input, the final sample includes 21 firms demonstrably engaged in chemical or pharmaceutical production as their core activity, 15 of which are subsidiaries or affiliates of transnational corporations[1.] To reconstruct firms' technological and organisational trajectories, all Financial Newspaper articles published between 2000 and 2025 were automatically extracted and queried using a GPT-based natural language processing pipeline. A consistent prompt was applied to extract event-based data for each firm. The resulting narrative sheets captured key dimensions of technological activity and structural embedding, including turnkey acquisitions and licensing (suppliers, technologies, destinations), the establishment of research and engineering centres (location, focus), evidence of patenting or innovation, modernisation investments, and value chain relationships (customers, suppliers, competitors). Where available, information on state aid (amount, purpose, timing) was also included. These reconstructions formed the basis for categorising firms into learning regimes.

An inductive-deductive approach was used to construct a typology of learning regimes across the sampled firms. Building on theoretical contributions from absorptive capacity theory (Cohen & Levinthal, 1990; Zahra & George, 2002), dynamic capabilities (Teece et al., 1997; Lee, Szapiro & Mao, 2018), and GVC governance (Gereffi et al., 2005; Pietrobelli & Rabellotti, 2006), firms were assigned to regimes based on their mode of learning (e.g., execution-based, task-based, residual autonomous), their degree of autonomy in decision-making and innovation, and their relational positioning in global or regional value chains. Governance forms, such as captive, satellite, or commercial interface nodes, were used to identify structural constraints and potential transition paths. Firm ownership, licensor relationships, and the presence or absence of IP-generating functions were integrated into this typologisation process. The regimes were validated through triangulation between narrative data, publicly available company reports, and expert secondary sources.

Complementing the qualitative firm narratives, financial time series data were collected for 21 core firms using public accounting databases and company registries. An additional 36 companies were included based on co-ownership patterns, reflecting broader holding structures. The dataset captures turnover, profit, and employment levels. Collectively, these firms employed around 12,000 people and generated €4.9 billion in turnover. While turnover was evenly split between domestic and FDI-led firms, profit distribution was skewed, 61% accrued by foreign-owned companies. These data support comparisons of financial accumulation, investment intensity, and firm responses to shocks such as the 2008 financial crisis and the COVID-19 pandemic. Patent data from Google Patents were used to track firm-level innovation trajectories, focusing on Romanian filings from 1960 to 2025. Together, the financial and patent datasets offer a complementary lens for positioning firms within the proposed typology of learning regimes.

To assess the integration of firms into the national innovation system, a database of Romanian chemical and pharmaceutical research institutes was constructed, including both academic and applied science institutions. Using the Web of Science Core Collection, all publications authored by these institutes between 1975 and 2023 were extracted. Bibliometric analysis included co-authorship structures, citation networks, journal impact factors, and funding source metadata.

The combined use of reputational firm selection, narrative reconstruction, typological reasoning, and bibliometric mapping enables a granular analysis of how learning regimes emerge, stabilise, and, occasionally, transition in an advanced peripheral context. Nevertheless, several limitations merit attention. First, reputational sampling may overlook low-profile but technologically dynamic firms, especially in niche or emerging sectors. Second, dependence on public reporting and journalistic archives risks omitting informal learning processes or proprietary innovation strategies. Third, co-authorship-based bibliometrics provide only a partial view of firm-science relations, often missing informal collabourations and unpublished contract research. Despite these constraints, the integrated methodology offers a robust foundation for examining how global integration, state intervention, and national research capacity shape firm-level technological trajectories under structural constraint.

1 Aectra, Agricover, Ameropa, Azomures, BASF, Bayer, Brenntag, Chemark, Chimcomplex, CICH, Corteva, Gedeon Richter, Henkel, Interagro, Nitramonia BC, Plantagrocom, Rifil, Silka, Syngenta, Terapia, Zentiva.

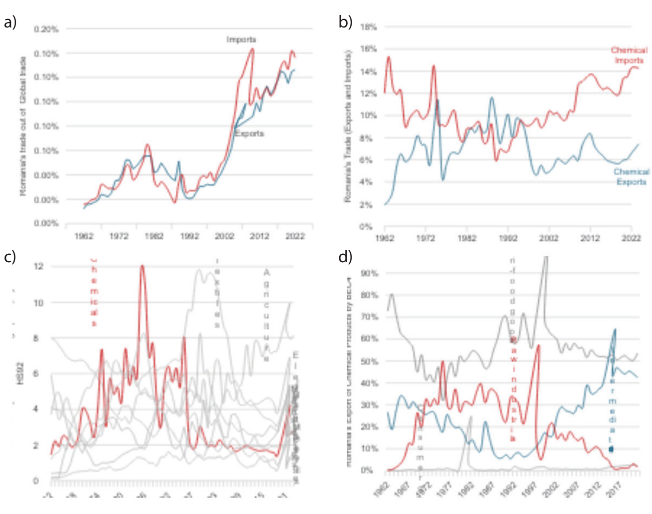
Results

4.1 Socialist learning regimes as institutional infrastructures

Romania's socialist-era chemical industry did not emerge as a spontaneous or uncoordinated industrial agglomeration, but rather as a state-engineered ecosystem anchored in vertical integration and export orientation. From the late 1950s to the 1980s, large-scale chemical platforms operated under direct coordination with sectoral research institutes and design centres, enabling the country to position itself as a competitive exporter of intermediate goods within COMECON and on selected Western markets.

Figure 1 captures this configuration. Although Romania's global trade share remained modest throughout the period (panel a), chemical products held a structurally significant role in both exports and imports (panel b), with a consistently high trade footprint. Panel c shows that during the 1970s and early 1980s, Romania's revealed comparative advantage (RCA) in chemicals rose sharply, surpassing other sectors such as metals and machinery, and remaining well above the RCA threshold of 1 for over two decades. Panel d illustrates the functional orientation of these exports: during the late socialist period, Romania's chemical sector was dominated by raw industrial goods, with intermediate goods becoming increasingly important after EU accession in 2004. Capital goods were entirely absent, while consumer goods played only a marginal role. Agri-food-related chemical products absorbed the largest share of export volumes. This functional structure reflects a knowledge governance model centred on process engineering, feedstock transformation, and synthetic input production, rather than final-product innovation or capital equipment manufacturing.

Figure 1. Romania's export structure and trade positioning under socialism and post-socialist integration (1962–2021)



(a) Romania's share in global exports; (b) Share of chemical products in Romania's total exports and imports; (c) Revealed Comparative Advantage (RCA) in selected HS92 export categories; (d) Functional composition of Romania's chemical exports by BEC4 classification: agri-food, intermediate, raw industrial, and consumer goods.

These capacities were not accidental. They were institutionalised in a triadic learning architecture consisting of:

(1) design institutes, such as IPIP Ploiești, responsible for translating imported technologies into functional plant architectures;
(2) mechanical repair factories, often embedded within industrial platforms (e.g., FEC Ploiești), which specialised in maintenance, replication, and internal equipment production; and
(3) chemical R&D institutes like ICECHIM or the on-site Research Service at Oltchim, which adapted inputs, developed new formulations, and stabilised production processes.

Each of these institutions contributed to a distinct mode of learning: learning-by-absorption (via turnkey plants and licensed equipment), learning-by-repairing (improvisation and local substitution), and reverse engineering and recalibration (partial replication under constraint).

Table 1 maps these mechanisms onto specific organizations, illustrating how some of them transitioned, transformed, or disappeared after 1989.

Data source: Author's computation based on Atlas of Economic Complexity (Hidalgo et al., 2007) as available at Harvard's Growth Lab Viz Hub.

Table 1. Socialist learning mechanisms and their organizational trajectories

Socialist Learning Form	Illustrative Organization (Historical)	Current Entity (Post-1989)	Ownership Type	Current Learning Regime
Turnkey learning-by-absorption	Borzești (Lurgi), Râmnicu Vâlcea (Monsanto)	Chimcomplex (Borzești + Oltchim, SCR Group)	Domestic (SCR, Romania)	R3.Residual Autonomous
Repair-driven local substitution	FEC Ploiești (Chemical Equipment Factory)	Part of Chimcomplex	Domestic (SCR)	R3/R4
Reverse engineering & stabilisation	ICECHIM, Oltchim Research Centre	ICECHIM (fragmented), Chimcomplex	Public/ Domestic	R2/R3
Vertically integrated engineering-lab model	Oltchim, IPIP Ploiești	IPIP (export turnkey), Chimcomplex	Domestic / GVC clients	R3 (Chimcomplex)/ R2 (IPIP)
Socialist FDI enclave (modular, isolated)	RIFIL Săvinești (JV with Fraver)	RIFIL (Fraver, Italy)	GVC (foreign)	R1.Execution/ R4.Commercial

Rather than accessing global technology markets through full licensing or integration, Romania operated under conditions of technological exclusion. Western firms such as Lurgi, Monsanto, or Zimmer rarely shared source codes or proprietary catalysts. Learning instead occurred through ingrained adaptation: reinterpreting technical manuals, improvising with local inputs, and reverse-engineering operating procedures. Romania thus became a paradigmatic case of semi-peripheral technological capability development, where knowledge was internalised not via codified transfer but through experimental recalibration and bricolage. These learning processes were stabilised through institutional routines and career structures that rewarded problem-solving under constraint, creating what might be described as an 'industrial pragmatics of survival'.

One important exception was the RIFIL fibre plant at Săvinești. Created in 1973 as a joint venture with the Italian firm Fraver, RIFIL operated under strict technological boundaries. While formally part of the Săvinești platform, it functioned as a closed enclave with proprietary Italian machinery, no cross-organizational learning, and minimal integration into the national innovation system. In contrast to the vertically embedded logic of socialist platforms, RIFIL anticipated post-socialist patterns of modular GVC integration, serving as a preview of what would become regime R1 (execution-based) and regime R4 (commercial relay) under foreign ownership. Its existence underscores that collective learning was not universal under socialism: some industrial structures functioned, even then, as isolated nodes of external compliance.

4.2 Post-socialist fragmentation and GVC repositioning

The institutional fabric that had supported socialist-era learning collapsed rapidly after 1989. Platforms that once integrated research, design, and production were disarticulated through poorly sequenced liberalisation and privatisation. Many public research institutes lost funding or were converted into quasi-academic entities, while state-owned combines were fragmented and sold, often to investors lacking industrial experience or capital. The loss of coordination between production and research infrastructures, such as ICECHIM's vertical linkages to chemical platforms or IPIP Ploiești's turnkey design ecosystem, created a landscape where capability accumulation was no longer structurally embedded. In many cases, post-privatisation ownership was driven by asset stripping or speculative conversion, as in the dismantling of the Târnăveni, Victoria, or Turnu Măgurele platforms. Others, like Oltchim and Faur București, entered prolonged decline and insolvency, losing both production capacity and institutionalised knowledge systems. These breakdowns marked more than the loss of capital stocks; they represented a rupture in the institutional infrastructure of learning.

Yet not all firms followed this trajectory. Enterprises such as Chimcomplex, Antibiotice Iași, and Azomureș retained or rebuilt technical infrastructures and partly recovered capabilities. Chimcomplex consolidated two historically distinct platforms, Borzești and Oltchim, into a private conglomerate encompassing R&D, mechanical engineering, and production facilities. Antibiotice Iași repositioned itself as a generics-based pharmaceutical exporter while maintaining links to public research. Azomureș, acquired by Ameropa in 2012, modernised production lines and environmental compliance, though without major investment in domestic innovation capacity. These exceptions confirm that firm-level survival was often tied to the historically embedded infrastructure or to post-2000 reconsolidation strategies. In contrast, smaller platforms such as Făgăraș, Târnăveni, and Săvinești (outside RIFIL) were decapitalised and erased from the production landscape (see Mihály 2023 for Săvinești).

Figure 1 also shows the consequences of this institutional rupture in trade dynamics. While Romania's chemical exports grew significantly after 2004, the structure of this growth reflects GVC reintegration more than capability upgrading. Between 2004 and 2022, chemical exports quadrupled in volume, rising from approximately €700 million to over €3.2 billion. However, this expansion was driven primarily by low value-added segments: fertilisers (Azomureș), bulk intermediates (Chimcomplex), and contract generics (Zentiva). Simultaneously, many of the firms involved in more complex synthesis (e.g., Faur, Frigotehnica, Victoria) ceased operations or were restructured into non-industrial uses. This decoupling between export growth and capability upgrading is depicted in Figure 1 panel d: a quantitative recovery in intermediate goods exports, but with limited evidence of qualitative upgrading or innovation.

By the 2020s, the chemical sector had coalesced into a dual structure. On one side, export-oriented firms owned by multinationals or logistics intermediaries operating under regimes of execution and commercial relay (R1, R4); on the other, legacy domestic producers sustaining residual forms of learning (R3) with partial R&D and engineering capacity. The former includes firms such as Corteva, Syngenta, or Bayer, which operate regional distribution or packaging hubs with limited technological autonomy. The latter category, Chimcomplex, Antibiotice, InterAgro, retain institutional residues from the socialist period and have leveraged them, with varying success, into production-oriented configurations. Yet as the following sections show, these post-socialist learning configurations operate in relative isolation, unsupported by industrial policy or innovation funding. The outcome is a fragmented, GVC-dependent ecosystem where exports have increased, but internal capacity to accumulate or diffuse knowledge remains weak and uneven.

4.3 Typology of learning regimes

To understand how Romania's chemical firms currently accumulate, or fail to accumulate, technological capabilities, we propose a typology of learning regimes. This framework draws on literature from GVC governance, capability accumulation, and innovation systems (e.g., Morrison, Pietrobelli & Rabellotti, 2008; Pietrobelli & Rabellotti, 2011; Lema, Rabellotti & Gehl Sampath, 2018), focusing on three core dimensions: (a) structural position in GVCs, (b) autonomy over production and innovation processes, and (c) dominant learning modalities. The resulting classification captures five distinct configurations: execution-based (R1), task-based (R2), residual autonomous (R3), commercial relay (R4), and interface-based (R5). These regimes are detailed in Table 2, which synthesises the learning logic, knowledge access, innovation capacity, and autonomy associated with each type.

Table 2. Typology of learning regimes in Romania's chemical industry

Dimension	1. Execution-based learning	2. Task-based technical node	3. Residual autonomous learning	4. Commercial relay	5. Imagined interface
Position in GVC	Captive production node	Satellite engineering node	Peripheral independent firm	Market logistics interface	Local sales node
Learning mode	Learning-by-doing under SOPs	Execution of defined tasks	Reverse engineering, embedded routines	CRM & supply chain learning	Branding & client feedback
Knowledge access	None	Operational access only, no IP	Partial, some national patents	None	Commercial only
Spillovers	None	Symbolic only	Moderate	None	Symbolic only
Autonomy	Zero	Very low	Medium	Zero	Zero
Participation in innovation	None	Minimal	Limited	None	None
Capability accumulation	None	Episodic	Stabilised	Commercial routines only	Imagined, not practiced

Table 3. Industrial learning regimes and corresponding firms

	1. Execution-based learning	2. Task-based learning under external coordination	3. Residual autonomous learning	4. Zero-learning commercial intermediation	5. Market-interface learning
Type of Learning	Procedural, without access to knowledge	Fragmented technical tasks, without autonomy	Adaptive, with own routines and reverse engineering	Commercial, logistic, no technological function	Branding, symbolic commercial adaptation
Typical for	Integrated production subsidiaries	Local R&D centres under HQ control	Former combines or domestic producers	Distributors and importers	Marketing subsidiaries with no productive function
Associated Firms	BASF, Bayer, Corteva, Sika, Chemark Rom, Hankel	Zentiva, Terapia, Gedeon Richter, Rompharm, Biofarm	Azomureș, Antibiotice, InterAgro, Chimcomplex, CICH, Nitramonia BC, Rifil	Aectra Plastics, Ameropa, Albis, Kasakrom, Alcedo, Agricover Distribution, Plantagro	Syngenta Agro, Brenntag

Regime R1 characterises firms functioning as tightly governed production subsidiaries under multinational control. Entities such as BASF, Bayer, or Corteva execute predefined processes, with no access to proprietary knowledge or influence over product design. Learning is procedural, driven by compliance with standard operating procedures (SOPs) and quality control systems dictated by headquarters. No R&D is conducted locally, and spillovers are absent. This configuration resembles the modular 'turnkey' structure discussed in Section 4.1 and continues the enclave logic seen in firms like RIFIL during socialism. As summarised in Table 3, these firms are export intensive but structurally incapable of capability accumulation.

R2 describes firms with slightly more autonomy, typically in generic pharmaceuticals or contract formulation. Examples include Zentiva, Terapia, and Gedeon Richter, where limited technical discretion exists in analytical development, regulatory compliance, or packaging design. These firms participate in relational GVCs where certain functions, such as quality assurance or batch stability testing, are delegated, but product innovation remains centralised. Access to knowledge is operational, not creative: they may execute defined tasks but not generate new intellectual property. As shown in Table 3, these firms conduct local R&D, but within narrow parameters dictated by parent corporations.

R3 comprises firms retaining partial autonomy and infrastructure from the socialist era, such as Chimcomplex, Azomureș, Antibiotice, and Sinteza. They rely on legacy engineering, R&D units, reverse-engineered production routines, and occasional collaboration with public research institutes. Learning is path-dependent and grounded in institutional memory, with limited but locally rooted innovation. Some R3 firms register national patents, typically in low- or mid-complexity domains. Table 4 depicts this regime as medium in production and innovation capability yet structurally decoupled from global innovation flows.

R4 defines firms acting as intermediaries or logistical platforms, without production or innovation functions. These include distributors like Brenntag, Agricover, or Aectra, whose core role is managing sales, warehousing, and regulatory mediation. Learning is commercial and relational, cantered on CRM systems, logistics, or regulatory compliance, but with no R&D, product development, or technical autonomy. Despite frequently receiving state aid for export facilitation or infrastructure, these firms contribute little to domestic knowledge systems. Table 3 lists several such entities, often misclassified in policy discourse as 'export performance' despite lacking production capacity.

R5 includes marketing-oriented subsidiaries such as Syngenta Agro, performing branding, client adaptation, or symbolic localisation for international parent companies. These firms have neither production nor R&D functions but represent the 'face' of multinational products in the Romanian market. Learning is entirely symbolic or commercial, interface management, not technological accumulation. This regime, though minor in number, is often privileged in innovation policy imaginaries that conflate market presence with innovation potential. As shown in Figure 4, these firms rank low on all capability dimensions and represent aspirational rather than functional integration.

These five regimes differ not only in capabilities but also in institutional embedding, reflecting both socialist-era legacies and contemporary GVC integration. While R1 and R4 dominate numerically, especially around Bucharest and Ilfov, regimes R2 and R3 hold most of Romania's remaining industrial knowledge base. As shown in Table 3, only firms in R2 and R3 conduct R&D, albeit with distinct logics and outcomes. Table 4 visually maps how each regime aligns with production, innovation, and R&D capabilities. This typology informs the following analysis of institutional supports and barriers to regime transitions.

4.4 Institutional anchoring: research, state aid, and industrial policy

Learning regimes are not solely outcomes of firm strategy; they are deeply shaped by the institutional environments in which firms operate. In Romania's chemical sector, three dimensions of institutional anchoring are especially relevant: (a) access to public R&D systems, (b) alignment with state aid programs, and (c) integration into industrial policy tools such as innovation vouchers, cluster support, or platform renewal. As shown in Table 5, these supports are unevenly distributed across regimes. Paradoxically, residual autonomous firms (R3), those most capable of domestic learning, receive the least alignment or support. This pattern stems not from market underperformance but from institutional misalignment, as industrial policy often targets visibility metrics (e.g., export shares or investment volumes) rather than structural capability-building.

As shown in Table 7, annual patent registrations peaked in the mid-1970s, followed by fluctuations and a sharp collapse after socialism's fall. Between 1967 and 1989, over 1,293 patents were registered by key domestic firms like Terapia (n=296), Antibiotice (n=254), Biofarm (n=249), and Chimcomplex's predecessors (n=130). Multinational companies selling turnkey factories into Romania, such as Bayer (n=226) and BASF (n=30), also registered patents locally for licensing and protection. These figures reflect a dense socialist innovation infrastructure centered on vertically integrated production-research platforms, where R&D, engineering, and production were institutionally embedded.

Table 4. Regimes and innovation outcomes: a typology-outcome matrix

Learning Regime	Production Capability	Innovation Capability	R&D Capability
R1.Execution-Based	High	None	None
R2.Task-Based	High	Low	Low
R3.Residual	Medium	Medium	Low
R4.Commercial Relay	Low	None	None
R5,Interface-Based	Low	Low	None

Table 5. Institutional anchoring across learning regimes

Learning Regime	Public R&D Linkages	State Aid Received	Legacy Infrastructure	Policy Alignment
R1.Execution-Based	None	Frequent (logistics, infra)	Weak	High (symbolic, exportist)
R2.Task-Based	Partial (QA functions)	Moderate (pharma programs)	Urban legacy factories	Medium (health, generics)
R3.Residual Autonomous	Strong (historical labs)	Low or blocked	Dense, underused platforms	Low (ignored in instruments)
R4.Commercial Relay	None	Frequent (trade, logistics)	None	High (GVC trade indicators)
R5.Interface-Based	None	Symbolic or promotional	None	Very high (start-up discourse)

Table 7. Patents registered in Romania by company and period

Company	1960-1989	1990-1999	2000-2025	Total
Terapia	296	5	2	303
Antibiotice	254	18	4	276
Bayer	226	34	0	260
Biofarm	249	0	1	250
Chimcomplex	130	76	7	213
CICH	55	0	0	55
BASF	30	12	1	43
AzoMures	16	7	0	23
Others (7)	37	15	6	53
Total	1293 (87%)	167 (11%)	21 (1%)	1481 (100%)

After 1990, domestic patent output collapsed: only 167 patents were registered in the 1990s and just 21 from 2000 onward. Among the few firms sustaining patenting were Chimcomplex (n=76) and Antibiotice (n=18). Multinational firms continued registering process-related patents in Romania for legal protection or adaptation; Bayer (n=34) and BASF (n=12) are notable examples. Most surviving firms in the residual learning regime (R3) ceased patent registration, shifting focus to process adaptation, compliance, and tacit knowledge upgrading. In contrast, major FDI-driven firms (R1, R2), though technologically advanced in their parent groups, generate little domestic intellectual property. Most recent patents in Romania are legacy continuations, legal formalities, or minor technical tweaks, thus not signals of systemic innovation or capability accumulation.

The erosion of formal innovation outputs mirrors broader transformations in the research infrastructure. Over the past two decades, Romania's chemical and pharmaceutical research field has undergone major reconfiguration. Once a vertically integrated network of industrial research institutes linked to socialist-era combines (e.g. Petrobrazi, Arpechim, Săvinești), it has become a fragmented, partially autonomous ecosystem. Following the post-1990 collapse or acquisition of many industrial partners, these institutes lost their direct technological beneficiaries. As of 2025, Romania's chemical research infrastructure comprises 24 publicly funded institutes and laboratories that originated as vertically integrated R&D units within socialist industrial platforms. To assess their contemporary role, we conducted a full-query bibliometric analysis in Web of Science using affiliation-based filters targeting all 24 entities, limited to Romania. Since 2004, Romania's chemical research landscape has been shaped by successive waves of national and European funding, especially through national R&D plans that increasingly relied on EU instruments and, more recently, Horizon Europe. The 2007-2013 period marked a peak in co-authored publications and industry-research collabourations, driven by strategic partnership schemes from the second funding cycle. A downturn followed during 2010-2014 amid broader fiscal constraints, but momentum returned after 2016 with the third national research programme and Horizon 2020 alignment. The current phase (2022-2025), shaped by the fourth national plan, the National Recovery and Resilience Plan, and Horizon Europe, continues this partial reconnection between research infrastructure and the industrial sector.

Despite these opportunities, only a few research institutes, such as the National Institute for Research and Development in Chemistry and Petrochemistry, the National Institute for Chemical-Pharmaceutical Research, and the "Petru Poni" Institute of Macromolecular Chemistry, along with, to a lesser extent, institutes for electrochemistry and isotopic technologies, have developed recurrent, project-based collaborations with industrial actors like Terapia, Zentiva, Unilever, or BASF. These partnerships remain largely episodic, focused on pilot-scale innovations in excipient development, reactor engineering, or chemical formulation, and rarely mature into long-term innovation trajectories. Nonetheless, these institutes have significantly increased their scientific autonomy and international visibility, supported by European funding and high-impact journal publications.

Technical universities, such as the Polytechnic University of Bucharest, the Technical University of Cluj-Napoca, the Polytechnic University of Timișoara, and Babeș-Bolyai University, have become key co-authorship nodes, bridging institutional fragmentation and enhancing Romania's presence in transnational knowledge networks. However, many smaller or regionally located research institutions remain marginalised, with limited integration into global science or industrial innovation. Residual learning regimes (R3) lack a stable interface with external R&D systems, undermining their potential to translate existing competencies into cumulative innovation pathways.

Romania's state aid architecture in the chemical sector, especially post-2014, has provided substantial financial support, but often without conditions that foster capability accumulation. As Bulfone (2022) argues in the broader EU context, 'no-strings-attached' aid tends to reinforce existing structures rather than transform them. The analysis of 174 state aid projects between 2015 and 2023 under Government Decision 807/2014, and 64 under 332/2014 (see Table 8), reveals a pattern of non-selective support, with the chemical and pharmaceutical sectors receiving a marginal share of incentives compared to automotive and electronics. Notably, firms like Antibiotice Iași (R3), Detergenți (R3), and Teraplast (R4) received limited but meaningful funds for modernization. However, these appear sporadic and misaligned with broader capability-building strategies. Firms in execution regimes (R1, R4), such as Omnia Europe, Corteva, and Bayer, benefit from export or infrastructure schemes without obligations related to innovation, spillovers, or workforce training, reinforcing low-complexity roles in global value chains.

Table 8. State aid beneficiaries in Romania's chemical industry (2015-2023)

Firm Name	Regime	Year	Grant (mil. €)	Notes
Antibiotice	R3	2023	34.5	Only firm with documented R&D and export integration
Detergenti	R3	2019	51.9	Domestic capital, production of chemical cleaners
Teraplast	R4	2018, 2020	~16.1	Multiple tranches, no known R&D unit
Omnia Europe	R4	2018, 2022	~117.3	Export logistics, no in-house production
Teraglass Bistrița	R4	2018	3.45	Associated with Teraplast Group
Teraplast Recycling	R4	2022	11.17	Recycling branch of Teraplast
Terabio Pack	R4	2020	11.59	Bioplastics offshoot, no proven innovation
MG TEC Industry	R2	2018	80.03	Some links to pulp/paper and packaging chemistry
Pet Star Recycling	R4	2018	18.96	PET recycling, downstream in plastic value chain

The geography of industrial infrastructure exacerbates these mismatches. While legacy platforms such as Borzești or Iași retain usable production and research facilities, newer industrial parks focus on logistics, services, or assembly. As of 2025, the Ministry of Development listed 116 publicly operated industrial parks under Law 186/2013. Most remain oriented toward general-purpose manufacturing, logistics, or automotive assembly. A few parks exhibit chemical or bio-industrial orientation, Sinteza (Oradea), Nitroparc (Făgăraş), and TeraPlast (Sărăţel, Bistriţa-Năsăud), but these are isolated cases rather than part of a coherent innovation network. Among them, only Sinteza has achieved meaningful integration with a major chemical producer through its acquisition by Chimcomplex. Others, like MG TEC in Dej, represent marginal sector overlaps, focused more on pulp-based packaging than core chemical processing. Public investment programs rarely prioritise brownfield revitalisation or platform-specific upgrading. Consequently, R3 regimes operate on ageing yet functionally dense platforms, while R1 and R4 regimes benefit from spatial and infrastructural advantages despite lacking innovation capacity. The legacy advantage remains stranded, lacking institutional connectors or modernisation schemes. Alongside spatial and policy mismatches, symbolic framings in innovation policy further distort regime alignment.

Symbolic framings in innovation policy further deepen these distortions. R5 marketing subsidiaries, lacking R&D or production functions, are often valorised in policy discourse via start-up grants or interface innovation programs. Syngenta Agro, for instance, benefits from visibility-based incentives despite having no innovation capacity. In contrast, material producers with internalised technical routines are excluded as outdated or invisible within policy frameworks. The result is a systemic bias toward visibility and image over embedded capability.

4.5 Transitions and blockages across learning regimes

While transitions between learning regimes are possible, they are rare, nonlinear, and structurally constrained. Two primary transition paths can be identified. The first, contractual pathways, emerge when firms initially positioned as distributors or production outposts (R1, R4) develop backward linkages or gain delegated R&D roles through supplier contracts, quality mandates, or localisation pressures. These transitions are most evident in task-based pharmaceutical firms (R2), which have partially evolved from execution routines under GVC relational governance. The second, residual transitions, occur when legacy domestic firms (R3) leverage infrastructural residues, old labs, experienced personnel, and embedded routines to reconstitute innovation functions. However, both pathways remain exceptional, highly context-dependent, and vulnerable to institutional discontinuity or market shifts.

Beyond contractual paths, a second cluster of mechanisms involves relational feedback from clients, suppliers, or national authorities. In rare cases, Romanian

Table 9. Transition cases and enabling/constraining factors

Firm	Initial Regime	Observed Transition	Enabling Factor	Main Obstacle	Outcome
Antibiotice Iași	3. Residual Autonomous Learning	Toward R2. Task-based (public collaborations)	Historical ties with universities	Lack of capital for scale-up	Limited but stabilised partnerships
Chemark Rom	3. Residual Autonomous Learning	Toward R4. Commercial Relay (shift to distribution)	Extended commercial network	Low absorption of innovation	Functional conversion, but no innovation
Chimcomplex Borzești	R3.Residual Autonomous Learning	Remains in R3 (failed co-innovation attempts)	In-house industrial capacity	Fragmented governance	Stagnant capabilities, risk of decoupling
Azomureș	3. Residual Autonomous Learning	Toward R2. through partial technological upgrade	Foreign investment and partnerships	Incoherent industrial policy	Uncertain trajectory, with upgrade potential
Interagro	3. Residual Autonomous Learning	No transition, technological stagnation	Centralised corporate control	Isolation from innovation ecosystems	Organisational regression
Terapia	2.Task-based Learning	Toward R3. internal routine consolidation	Access to internal technological routines	No external research partnerships	Local growth, but no spillovers
Rompharm Company Group	2.Task-based Learning	No transition, stagnation in subcontracting	Easy access to emerging markets	High contractual dependency	Persistence in subcontracting

firms have upgraded by adapting to procurement demands (EU tenders) or entering long-term contracts that favour process refinement or ISO-based capability-building. Yet these mechanisms remain weakly institutionalised. More common is symbolic learning, where firms in R4 or R5 receive market signals about client preferences, regulatory trends, or branding strategies but fail to translate them into productive innovation. This feedback sustains only interface adaptation, not capability accumulation.

In practice, regime mobility is rare. Firms often remain locked in their original configurations, especially amid persistent structural barriers. Execution-based subsidiaries are legally and technologically tied to headquarters; distributors are excluded from R&D circuits; technologically-inherited firms face capital constraints, policy neglect, and path dependency. As shown in Table 9, these constraints are reinforced by an institutional landscape that privileges visibility and market presence over embedded learning. Thus, the typology is not merely descriptive but historically sticky, each regime reproduces itself through institutional inertia, ownership structures, and policy blindness.

Attempts at regime shift often fail. IPIP Ploiești, once a central design institute, pivoted to international turnkey oil refining contracts but failed to re-establish domestic industrial ties. Faur București transitioned from railway and chemical engineering to defence production before eventual dissolution. Oltchim, despite extensive infrastructure, endured years of insolvency before partial absorption by Chimcomplex. In contrast, firms like Antibiotice Iași show partial transition success through regulatory compliance and export orientation in generics. Yet even in these cases, the ceiling of innovation remains low: no firm has fully shifted from R3 to R2, nor from R2 to R1 with autonomy.

A clearer example of partial regime transition is the agro-chemical value chain built by Nitramonia BC, which, unlike Interagro or Chimcomplex, has developed a relatively coherent model of vertical integration. Since 2021, Nitramonia has acquired Chemgas Slobozia and the Nitroporos-Gladwell energy assets at Făgăraș, integrating fertiliser production with downstream grain trading and food processing via Cerealcom and Pambac, both under the same ownership. Energy and steam provision at Făgăraș are now partially internalised, stabilising key inputs. This model enables value capture across the chain, buffers input volatility, and exploits logistical synergies.

In contrast, Interagro's fertiliser platform fragmented after 2016. Although the group initially held a broad chemical portfolio, including Amonil, Donau Chem, and Amurco, it failed to sustain integration. Centralised ownership, weak coordination, and debt exposure triggered a series of divestments. Chimcomplex, by comparison, has concentrated on acquiring industrial capacity. After purchasing key Oltchim assets and minority holdings in Sistemplast, the firm launched a capital-intensive expansion in high-value chemical production. However, its strategy remains focused on upstream specialisation rather than integrated agri-industrial restructuring. These divergent paths show residual firms do not follow a uniform model: some, like Nitramonia, reconfigure legacy infrastructure into viable production systems and partial technological configurations, while others stall in incomplete transitions or pursue consolidation without deepening capabilities.

RIFIL is a distinct case, a former joint venture between the Romanian state and Italian group FRAVER, now fully controlled by Filivivi. Unlike domestic residual firms, RIFIL has maintained a stable enclave-like structure, integrating spinning, dyeing, and auxiliary services across seven production sites and affiliates (e.g., Novafil, Rolana Tex, Industria Filati Buzău). However, this integration is not based on local capability accumulation. Instead, RIFIL operates under strict corporate coordination, reproducing Italian know-how and exporting to the Filivivi network. No independent R&D centre exists in Romania; local labs are limited to quality control and minor adaptation. In this sense, RIFIL exemplifies a locked-in production enclave, insulated from domestic industrial policy or innovation ecosystems. Its vertical integration contrasts with Chimcomplex's or Interagro's fragmentary or speculative models, but also shows the limits of regime mobility when strategic control is externalised and learning remains bound to foreign routines.

The evidence indicates that Romania's chemical industry operates under a blocked learning regime: transition is theoretically possible but constrained by ownership, institutional incoherence, and lack of strategic coordination. The typology introduced in 4.3 and institutionally anchored in 4.4 now reveals its full significance, not just a map of learning types, but a matrix of (im)mobility. Without institutional redesign, targeted R&D alignment, conditional aid, and platform renewal, the industry is unlikely to escape its current structure: enclaves of residual capability coexisting with dominant regimes of functional subordination. This conclusion sets the stage for broader reflection on the future of innovation under dependent capitalism.

Discussion

The Romanian chemical industry illustrates the tensions of capability formation in an advanced peripheral context (May et al., 2024), where certain sectors attract FDI and are integrated into GVCs, yet systemic innovation remains limited. The learning regime typology developed in this article captures this structural tension. Execution-based (R1) and commercial relay (R4) regimes dominate numerically but contribute little to knowledge accumulation. In contrast, residual (R3) and task-based (R2) regimes show limited but tangible signs of innovation, though largely inherited or weakly supported.

This confirms that the legacy of a vertically integrated industrial model under socialism, combined with a fragmented post-socialist transition, has produced a stratified learning field. Unlike classical latecomer contexts where catching-up is state-coordinated (Amsden, 2001; Lee, 2024), Romania's industrial transformation unfolded with limited strategic direction and heavy reliance on privatization and FDI (Nölke & Vliegenthart, 2009). The result is a dual structure: commercial and execution nodes integrated into global firms, and isolated domestic firms preserving legacy capabilities.

The evidence shows that GVC integration in Romania's chemical sector has produced organizational stability, but not technological upgrading. While firms in R1 and R4 benefit from being situated along global distribution and compliance systems, they remain passive from an innovation standpoint. They execute SOPs, repackage products, and service global flows. This aligns with the 'captive supplier' model (Gereffi et al., 2005), where knowledge transmission is restricted, and autonomy limited.

The state's role in this configuration has been largely passive. As Bulfone et al. (2022) argue, many Eastern European countries developed a form of corporate welfare without conditionality, supporting industrial actors without leveraging that support to shape technological upgrading. Despite the existence of national R&D programs and EU cohesion funding, most firms in Regimes 2 and 3 reported relying on internal resources or European grants without long-term institutional coordination. Conversely, no structural incentive or policy discipline was applied to encourage knowledge diffusion from foreign-owned firms.

The near-absence of chemical firms among state aid beneficiaries highlights a structural misalignment between industrial policy and capability-building potential in Romania's advanced peripheral economy. Despite the sector's capital intensity and export promise, selective inattention and non-conditional support have entrenched an FDI-led growth model focused on execution and commercial relay regimes. Institutional efforts to foster innovation transitions in the chemical industry remain minimal.

Romania's policy toolbox lacks mechanisms to channel aid toward capability development in legacy sectors. Redirecting support away from unconditional execution regimes and toward selectively enabling transitional firms (R2-R3) could spur endogenous innovation and institutional anchoring.

This passive configuration has enabled commercially connected firms (R4) to scale without investing in innovation, while exposing R3-type firms to obsolescence. Even when firms like Chimcomplex or Antibiotice Iași developed internal R&D programs or pursued modernization, they did so under structural uncertainty and without systemic support. Some firms show tentative signs of transitioning from residual or task-based regimes to more complex configurations. In R2, Terapia and Zentiva sustain modest R&D efforts and are partially reintegrated into global pharmaceutical development cycles. In R3, Chimcomplex's post-2018 investment drive signals a reactivation of innovation through internal engineering and product diversification. Yet such transitions remain fragile.

The barriers are multifaceted. First, Romania's national innovation system (NIS) is fragmented, with firm-university collaborations remaining rare and largely transactional. Second, intermediary institutions, such as engineering consortia, applied research centres, or platform agencies, are largely absent, limiting the mediation of knowledge flows between public and private actors (Zylberberg, 2019). Third, the labour market for technical and R&D staff remains thin outside capital-intensive clusters.

The analysis confirms that Romania's chemical industry is predominantly embedded in GVCs through low-added-value, low-autonomy functions. FDI-led firms dominate by number and volume but operate under captive governance, with decision-making, design, and innovation centralised abroad. Despite integration into international supply chains, the sector remains peripheral, showing weak technological upgrading trajectories. National FDI stock reports reveal the chemical industry falls behind automotive, electronics, and IT in total capital and export sophistication. The few firms pursuing innovation, legacy public companies like Antibiotice Iași or privatised successors such as Chimcomplex, remain exceptions in an otherwise execution-driven landscape.

This configuration reflects a broader pattern in advanced peripheral economies: integration without transformation (Pavlínek, 2020), where access to international capital is not matched by conditions for local learning. The typology developed here provides a framework to identify which firm categories and GVC positions are more likely to sustain innovation, and where targeted policy intervention may be both possible and necessary.

Conclusion

This article has developed a typology of learning regimes in Romania's chemical industry to explore how firms build capabilities amid structural constraints and post-socialist transformation. Using firm-level narratives, innovation and patent data, institutional affiliations, and sectoral mappings, the analysis demonstrates that Romania's technological capability landscape mirrors the stratified logic of its integration into GVCs.

Five regimes were identified, spanning execution-based subsidiaries of multinationals to residual national firms preserving post-socialist technological routines. While commercial and execution regimes dominate numerically, only task-based and residual regimes exhibit signs of endogenous learning, often limited and institutionally unsupported. The FDI-led exportist model has stabilised portions of the sector but has done little to foster innovation upgrading or generate local spillovers. As a result, Romania remains confined to low- and medium-value segments of the chemical GVC, with few firms positioned to influence product or process development.

Institutional analysis reveals that the erosion of Romania's national innovation system, the fragmentation of research centres and the absence of conditionality in industrial policy have collectively undermined transitions toward more autonomous and innovative regimes. State support remains reactive and fragmented, lacking mechanisms to effectively target and enable firm-level upgrading, particularly for domestic or hybrid firms aiming to rebuild technological capacities.
These findings contribute to broader debates on learning under dependency, late industrialization, and the uneven geographies of innovation. By repositioning the chemical industry as a revealing case of advanced peripheral industrial development, the paper shows that the structural space for upgrading is present but underutilised, constrained by political and institutional inertia. Future research could extend this typology through comparative studies across Central and Eastern Europe, exploring the conditions under which regime transitions become viable.

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