



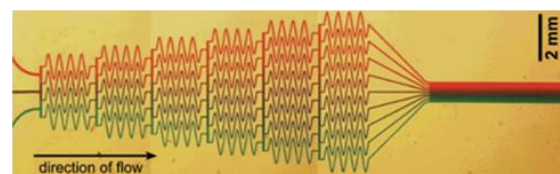
OUR VISION

- **The new era of Bio-inspired microfluidics industry**

Ever since the steam engine helped launch the Industrial Revolution, large-scale operations and overall general trends for **miniaturization** have boosted living standards and provided richer choices than our ancestors ever dreamed of. Production, efficiency and technology democratization increased, resulting in our current import-export market and a consequent improvement of the quality of life.

Along with great new opportunities, that progress came with significant downsides, the main one being **energy consumption, pollution** and **unstainable resources management**. The energy-intensive, sprawling industrial complexes that run chemical processes have unwittingly generated significant damages to the environment. Science indeed allowed many innovations with its unfortunate consequences, but also offered the hope that careful observation and experimentation might improve the industry significantly. Today, in our new era of technologies, science unveils new paradigms and revolutionary concepts for a **sustainable biomimetic industry**.

Throughout the evolution, nature has shaped within its fauna and flora, fabulous biological & reactional environments and architectures that exchange and interact with cells, molecules, fluids and minerals evolving within **complex and energy efficient system**. We see that in the mechanism hydrating the beetle in the deserts or in the giant sequoias transporting nutrients. Nature offers proven strategies and inspiring intellectual frame. By considering and emulating this evolution history, we are able to design advanced and **revolutionary ecological and sustainable solutions** for medical, energetical and environmental fields. From vessels, capillaries and cellular architectures, at all sizes, life is intrinsically and evoked by essence a **microfluidic based conceptual frame**, and those natural and proper patterns are the corner stone promises of the new revolutionary technology that Eden Tech brings: **Biomimetic & microfluidics together**.

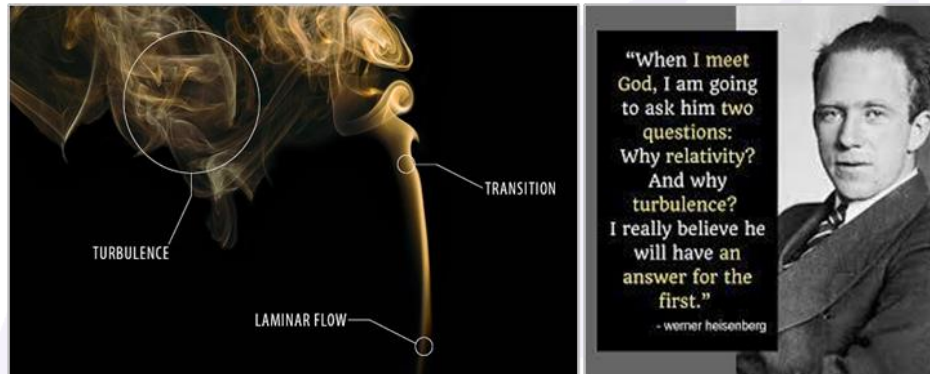


A large share of industry relies on fluidic processing in their operation with systems combining large reactors, heat exchangers, compressors and other pipes. Eden Tech can **miniaturize** them, in a revolution similar to the one microelectronics brought to the world of electronics. In the early days of electronics, the basic device was the vacuum tube. But as the potential of silicon as a material for making transistors was discovered, electronic devices became much more compact and less expensive, relying on low energy to run, leading to a global IT and societal revolution. Much like microelectronics, **size is key in microfluidics**. As the components get smaller, devices and energy effectiveness can rely on the remarkable laminar and chaos free properties of liquids at tiny scales to operate faster and more efficiently, while being cheaper and more sustainable to manufacture. Reactions are accelerated and highly yielded at the microscale (1 mm to 10 μm), integrating massive complex fluidic systems in a suitcase, operating at a rate of 1m³/s. Microfluidics manufacturing shares commonalities with that of microelectronics, the microfluidics revolution has been silently piggybacking on its electronic counterpart, becoming its legacy. Resolution and speed increased in microelectronics fabrication tools, and so has manufacturing capabilities of microfluidic devices. Eden Tech takes this even further by developing tools and processes specifically made for microfluidics rather than adaptation of microelectronics counterparts. It offers efficient solutions for researchers working on the development of microfluidic devices, while creating high impact solutions revolutionizing this industry.

- **Systems inspired by nature**

Natural systems optimized fluid treatment by performing liquids transport and complex reaction in **smart energy grid and miniaturized architecture**. This approach perfectly balanced the higher costs for pressure needs in the smallest vessels, from its benefits in term of reactivity effective and performance. Also, This approach minimizes energy losses by ensuring that the fluid is highly organized and free of turbulence. Around us, at millimetric scales and above, flow streamlines and vortices are everywhere chaotic, indeterministic with dominating non-optimal patterns. Above millimeter-scale, Fluids (liquids & gaz) enter readily into a turbulent regime when their Reynolds number passes 2300, and become chaotic.

Predicting turbulent motions has long evaded mathematicians and physicists: solving the main equations describing fluid flow - the notorious **Navier Stokes equations**- in a turbulent regime remains to this day one of the 7 millennium problems . In the famous words of Heisenberg, *“When I meet God, I am going to ask him two questions: why relativity? And why turbulence? I really believe he will have an answer first.”*



Turbulence may still not have a solution, but laminar flow does, and by using microfluidics, we **perfectly control fluids**, unveiling a new potential in research and technologies.

The Russian mathematician Kolmogorov studied the question in the world famous "energy cascade" model that he introduced in 1941. We consider that the energy injected into a large-scale flow is transmitted to the largest eddies, then is transmitted step by step to the smallest ones where it gets dissipated by viscosity. In the K41 series of papers, Kolmogorov predicted and gathered theoretically the **conceptual frame of microfluidics and biomimetic**, although the technology came 50 years later. At a level where the Reynolds number is equal to 1, the convective effects and the viscous effects become of the same order of magnitude. In other words, the smaller the channels are, the more the fluid's path is controlled, predictable, in other words, a laminar flow. This term finds its etymology in the Latin word 'lamina', meaning 'a thin layer of a material', and makes reference to a smooth flow in a fluid, where the particles in motion are guided to distinct layers.

Nature operates fluids **down to the smallest scales**, however, it emulates it, to handle large volumes over extended and perfectly controlled period of time . Blood circulates through a cardiovascular system where the smallest vessels are less than 5-10 microns but at a rhythm of 5L/min, ending to 7 tons operating daily, and this for years. Trees circulate hundreds liters of sap up to 100 meters without the need of a pumping mechanism. This exceptional performance, operating large volumes in small channels, is the result of the arrangement of the fluid circuitry to minimize energy losses, optimizing in parallel chemical and physical reaction. The smart architecture organizes a maximum number of channels into a compact processing area (leaves, lungs, kidneys), in a fractal like approach. Life is the result of **energy optimization** together with a balanced equilibrium of energy and reaction efficiency.

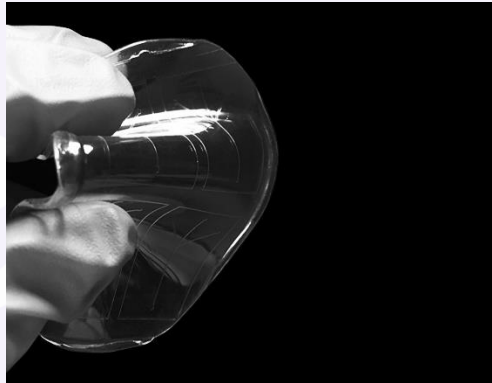
Working with laminar flows allows us to skillfully manipulate fluids and suspended elements, and we can direct, filter or insert them as we wish with high precision. Until today, this advantage of microfluidic technology is mostly found **in lab-on-a-chip , point-of-care or cell engineering systems**. For decades, fluids in small channels meant small volume, and the past technologies were meant to manipulate a few milliliters of fluids. Eden Tech breaks this paradigm and takes microfluidics beyond its limited, traditional use, creating a new concept of **Flowbleu**. The microfluidic revolution offers disruptive **high-volume solutions** against some of the most important challenges faced by humanity. A revolution, democratization and transformation for the industrial landscape, much like microelectronics did 50 years ago. Today, our latest technology is ready to reach the market, as it is the legacy of microelectronics and no longer needs all the time required back then.

- **Accelerating Microfluidic Innovation, in a seamless fashion from prototyping to industrialization.**

Microfluidics was born out of microelectronics research laboratories and for three decades, prototyping and manufacturing simply copied microelectronics fabrication processes. Indeed, microelectronics have defined the tools and means. The high machining complexity of electronics materials (silicone, glass, metals) implied slow and serial fabrication, even though microfluidics demonstrated early on successful operation when made out of polymers. It took over 10 years for polymeric microfluidic prototyping to develop, and even then, despite its great contribution in this technology's advances, it settled on a thermoset material cheap, transparent and easy to use but utterly incompatible with rapid prototyping and mass production. Design validation would take weeks, but production scale-up would still be very challenging. Microfluidic innovation should not take years and design validation should not take weeks.

Eden Tech offers a new solution: **Flexdym**, a prototyping polymer for chip fabrication in minutes that facilitates transition to mass production with advanced bonding & assembly properties, cells & sensors integration, and fast yielding, allowing massive microfluidic production for industrial application.

Also, to promote and spread microfluidic in education, research and industry, Eden will launch next quarter the EdenApp, a free online microfluidic design simulator for **rapid fluid flow validation**, as well as 3D printing and high-precision machining for the fabrication of high quality nano-scale molds including rounded profile ones.



Flexdym for microfluidic device fabrication

Our **Eden Materials** range of high-performance products is central to Eden Tech **Flowbleu** revolution. By promoting tools and systems for both prototype and product cycle generation, Eden is able to match today's industrial pace and enables new products and service **for high impacts applications**.

- **Biomimetic microfluidics impact for a New area of green industry**

“Nature should never be forced to produce like a factory. Factories should be inspired to produce like nature.”

In an encounter between Gunter Pauli and Eden Tech, a question has been raised: **Is it possible to use microfluidics technology to tackle the problem of microplastics ?** Eden Tech took on the challenge. By understanding the laws of Fluid mechanics, drawing inspiration from the patterns of nature and using our solutions for microfabrication, we take biomimetic microfluidics to a new horizon. We designed new applications for a **high volume processing in a compact design** to revolutionize the industry.

Our **ASCANDRA** line is the first ultra-compact water filtration system for microplastics designed to protect the ocean at coastal and rivers levels, which can also be deployed in industries and even at home. The system is small enough to fit any boat, yet powerful enough to remove **microplastics** at a depth of 20-50cm. It relies on a turbulence free microfluidic design that controls, positions, counts, directs, and finally concentrates microparticles (0.1-10 million fold). A fabulous microfluidic prowess designed to **treat 1m³/s**, that can be installed easily on boats or near rivers.



Ascandra for Microplastic remediation

AKVO is our water treatment solution targeting **micropollutants, bacteria and viruses**, dedicated to tertiary treatments for water production, water reuse, and sanitation prior discharge. It presents compactness and low-pressure loss which allows having a high-throughput flow rate and can treat **100 cubic meters per day**. It works with hydroxyl radicals, which are unstable and have a diffusion time of milliseconds that keeps them from traveling large distances. The microscale confinement enables an extraordinary control of micropollutants flowing through the channel and make them interact with "immobilized-like" hydroxyl radicals. As every knows now, closed confinement boost molecules interact, even more and more at microscale. This new solution preserves water access and quality, with the great potential for Giga Tons of energy saving. It allows Watertech democratization and Multi-dimensional impact (Social, political etc). **AKVO won the prize i-Lab by BPI in 2020.**



AKVO for water treatment

Our **GREEN HYDROGEN** (MacGhyver) solution makes possible highly-efficient large-production of **hydrogen from waste water and sea water**. Currently, the biggest energy loss in electrolysis systems is due to the space between the electrodes. When the current density increases, the loss follows, limiting production rates. By reducing that space to a few micrometers in a microfluidic device, we reduce losses significantly and enable high-current density operation for large production rates. Electrolyte composition contributes also to this energy losses, and to reach highest efficiency in macroscale systems, ultrapure electrolytes are required. With our microfluidic approach, we free the system from requiring ideal feed, and can explore alternative, **more sustainable electrolytes** to produce green hydrogen. Using wastewater as electrolyte, the electrocatalysis process generates hydrogen while degrading molecular and biological pollutants, to ultimately create clean water. Finally, the moving fluid between the electrodes carries the gas generated away from the electrodes, and the laminar flow in the system eliminates risk of mixing. As a result, the onerous and easily damaged membrane can be eliminated, for a more affordable and more easily fabricated device. This concept, ranked 1st at the European Commission, was recently **awarded a 3.5 M€ grant to create the first prototype**.

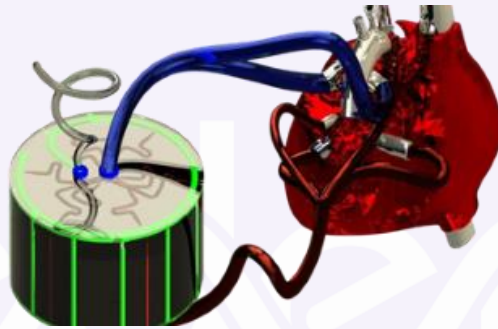
These three WaterTech projects are at the core of our **FlowBleu** revolution, and can have huge impacts on our lives. By a deep and rigorous study of the phenomenon of physics, an inspiration from the optimized patterns of nature and a strong will to make significant and sustainable changes, we aim at reducing negative environmental impacts while making significant improvements in energy efficiency, preserving our precious resources fresh water and ocean health.

- **Biomimetic microfluidics for healthier and fairer world**

Ultimately, biomimetic microfluidics can simply support the systems that inspired them, as we do in the development of our **MEDTECH line**. Our body has optimized its fluidic circuitry to reach the highest efficiency in blood functions, while limiting stressful forces. Under stress, blood initiates a thrombotic cascade that leads to clotting, a phenomenon that limits the amount of time blood-circulating medical devices (ECMO, cardiac assist, hemodialysis) can be used with a patient. Our biomimetic, microfluidic approach and the precise understanding of flow at the microscale enable us to create fluidic circuit that treat blood while **minimizing the impact of flow forces** (shear stress, velocity over the blood's path). The overall compactness of the device permits portability, liberating the patient from being restricted to bedrest. Deploying these solution earlier helps slow down the loss of vital functions, rather than waiting for patients to reach desperate conditions to be assisted while on organ-transplant waitlist. Overall, the biomimetic

microfluidic approach to medical devices helps the human body through human-inspired designs for more natural functional life.

“EDEN’s biomimetic system is the first of its kind to approach body-like performances. The compact, high-efficacy and low-thrombosis capabilities opens new hope for long-term support of patients, to slow the degradation of their organ’s function and offer a mobile lifestyle for more autonomy. This is a groundbreaking innovation for the field of pulmonary medicine” Dr. Olaf Mercier, M.D



LUNG Project for maximal oxygenation with minimal impact on blood

- **Nature is microfluidic, so is the future of our industries.**

With **Flowbleu** Revolution , Eden Tech opens a new era of industry. The compact solutions bring new opportunities for a decarbonized society, with highest impacts progress. As AI, BlockChain, synthetic biology and little few others today, we strongly believe, and have being very actively supported at French & European levels, that **Microfluidic & biomimetics synthesized** within the **FlowBleu** conception is at the core and yet to support and develop a fundamental & essential Deeptech, providing routes and inspiration for MedTech, CleanTech, EnergyTech and SpaceTech innovation & industry.