The use of active matter in research-creation practices: Using an artistic vocabulary for 4D printing of magneto-active polymers deployed in experimental and observation devices.

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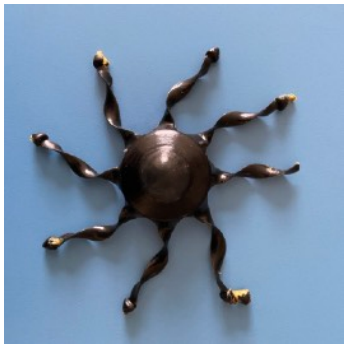
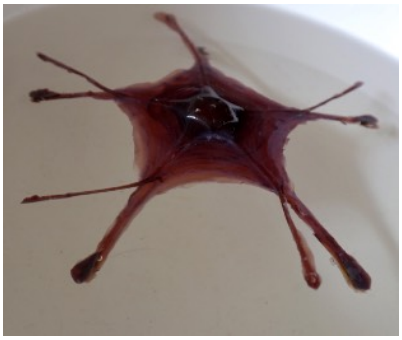
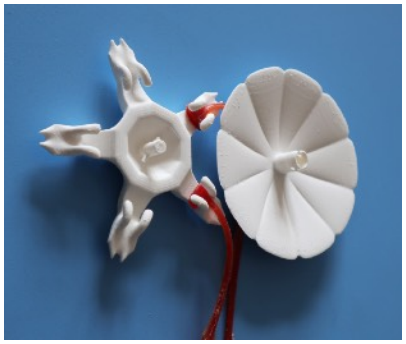




4D printing is the functional form of 3D printing [1]. Instead of printing only static objects, it is now possible to print functions. In other words, it is like embedding a piece of code...but in a material. Once the function is activated, the object will perform the programmed actions. A 4D printed object can thus adapt to its environment and evolve in a controlled manner through the application of stimuli. At the heart of this new technology, there are the smart and the functional materials. Among them active matter has become one of the keystone of the additive manufacturing revolution. Active matter systems are made up of monads that actively consume energy from the environment and transform it into mechanical work. Broadly speaking, active matter encompasses a variety of systems ranging from living beings, such as birds, cells and bacteria, to inanimate structures, such as colloidal suspensions, microswimmers, and molecular motors. The temporal evolution of these interacting entities shows a collective behavior with the formation of complex patterns. These ubiquitous phenomena range from the flocking of birds to the sorting and organization of cells in morphogenesis to the self-assembly of colloidal and molecular systems.
The use of self-assembly process of magnetic nanoparticles submitted to a magnetic field (the external source of energy) leads to the formation of chains-like structures. If these filamentary structures are embedded within a polymeric host matrix, a magneto responsive system is produced that can transform into complex and programmable mechanical movements, such as rolling, translation, stretching, shape-shifting, and folding/unfolding [2,3]. Thus, magneto-responsive polymers are at the heart of an intense research activity spanning from soft robotics and flexible electronics to energy harvesting, and medicine.



Within our research-creation practices, we use the 4D printing of magneto-responsive polymer to question the notion of behavior, a notion that is increasingly fundamental to contemporary artistic creation. The repertoire of forms is the result of a hybridization between various registers belonging to the plant world, more precisely the floral and the animal. The forms chosen are based on their dynamic potential, whether it results from physico-chemical exchanges or from a complex organism.
The test prototypes are composed from combinations of radial symmetries of echinoderms and actinomorphic flowers designing objects whose behavior will be guided by the positioning of magnetic charges. In particular, conversely to the mainstream research in material science, soft robotics and design, that mainly focuses on programmable objects and devices, we explore the notion of casualty.
We fabricate *behavioral* objects that, although possessing self-organized microstructures, manifest a set of actions that are not predictable, and not directly inferable from its environment. Centrally symmetrical radiating forms with elongated arms with several joint-like receptacles for the charges allow for a wide spectrum of movements.
It is not a question of mimicking nature but of using its assets and information to try to point out new movements under the influence of magnetism and therefore to design materials capable of activating them.

References

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[3] Simone Lantean, PhD thesis, *A novel approach to fabricate bioinspired programmable composite materials: the 3D Printing way*, Politecnico di Torino-Ecole polytechnique (2021)