S&T Foresight Workshop:
a quest for an interface between information and action

The concept of Stem Materials

In nature, living organisms consist of a limited number of primary components and chemical bonds organized in complex systems capable to adapt to diversified environmental conditions. Materials are very rarely adaptable, and often require a large number of components to achieve high performances in specific functions. Materials able to perform different functions and to respond to external inputs will become increasingly important. They will play a fundamental role in the additive production to the extent that these are designed and structured to perform specific operations and self-adapt to varying external conditions, without any additional device. This generation of materials can substitute robots in some applications, i.e. when communication and electronics are considered vulnerable aspects. Materials able to perform as sensors and actuators, accordingly to external environmental conditions for fulfilling different requirements, are still a challenge. These intelligent materials should be flexible in any context and condition, and possibly consist of primitive units, containing the minimal and sufficient number of components to perform a basic function, whose combinations can respond to specific requests of multi-functionality and adaptability. This is the conpets of STEM (Sustainable Transformative Engennered Multi-functional) Materials (http://www.foresight.cnr.it/working-groups/wg-materials).

The challenges

Many scientist already met to identify what scientific challenges are needed to tackle to implement the concept of Stem Materials (see also https://bmcmaterials.biomedcentral.com/articles/10.1186/s72833-019-0007-7). In this context, **one of the main scientific challenges to understand the operational functioning of complex systems, such as biological systems, is the role/meaning of the information, its transfer and interaction between the different agents.** Despite the large amount of data which can be accumulated on the transfer of matter and energy, the rules and processes which structure and organize the system in real networks that dynamically modify their topology in relation to external inputs, are still a matter of research in different disciplines. Whether you want to call it "semantics" or a functional analysis of the dynamics of topology (in space and time), the need is to understand **how the transfer of information can result into an action**. Any breakthrough in this regard will generate innumerable cross-cutting implications: from social communication, to robotics, to the synthesis of functional materials or medicines.

The workshop: how and why

The workshop will have a total duration of 9 hours and will be implemented remotely within three meetings. A week before the first meeting, presentations or small reflection points from the speakers will be distributed to facilitate the participation. The first two meetings will allow the speakers to briefly present their reflections. At each meeting, written questions will be collected, and distributed to all participants before the third meeting. At the third meeting, speakers will be invited to answer the questions, and all participants will debate and deepen the topics that they had time to reflect on.
Proceedings of the workshop are foreseen and, moreover, we plan to promote the editing of a joint article to be submitted to a peer-reviewed journal.

The workshop aims to stimulate a discussion between scientists from different disciplines on the problem of understanding the functionality of signals on different systems. The ultimate goal is to identify commonalities and fundamentals that will allow a mathematical description of the meaning/functionality of signals/communication.
In particular, the workshop will focus on syntax/semantics, music/synchronism and chaos/order. The ultimate goal is to identify clues and research lines of activity towards a bridge between information and action.

A quest for an interface between information and action

7, 9 and 20 April 2021 (remotely)

7 April (17:00 – 20:00 CET) Chair: Pier Francesco Moretti

17:00 – 17:20 Rationale of the workshop: from materials to immaterial concepts (**Pier F. Moretti**)
17:20 – 17:50 Languages of nature (**Cédric Gaucherel**)
17:50 – 18:20 The Music of matter (**Tom McLeish**)
18:20 – 18:50 Nature-inspired computing (**Andrew Adamatzky**)
Leg stretching
19:00 – 19:30 Emergence of organisms (**Andrea Roli**)
19:30 – 20:00 Strong AI and Quantum Brain (**Stuart A. Kauffman**)
Questions are collected on chat and on a living open access document

9 April (17:00 – 20:15 CET) Chair: Vasileios Basios

17:00 – 17:30 The generalization of the periodic table (**Vasil Penchev**)
17:30 – 18:00 A review of some ideas for a mathematics of biology (**Roberto Natalini**)
18:00 – 18:30 Synchronism (**Andrey Shilnikov**)
Leg stretching
18:40 – 19:10 Chaos, rhythms and processes in structure and function
(**Vasileios Basios & Yukio-Pegio Gunji**)
19:10 – 19:40 Signals in cells (**Jack A.Tuszyński**)
19:40 – 20:10 COMA-SAN: Innovative experiments on sensing biological communication
(**Marco Girasole & Giovanni Longo**)
20:10 – 20:15 Towards the third day
Questions are collected on chat and on a living open access document

20 April (17:00 – 20:00) Chair: Pier Francesco Moretti

17:00 – 17:20 Report and analysis of main points and questions
17:20 – 17:50 Dynamic information in complex networks (**Enrico Capobianco**)
17:50 – 18:20 Feedbacks: closing the loop (**Kathrine Peil Kauffman**)
Leg stretching
18:30 – 19:50 Debate
19:50 – 20:00 Next steps