



# From Athens School and Janus Facing Past and Future to the IEAE/UFSCar

Paulo César de Camargo<sup>1,5</sup>  · Roberto Antonio Martins<sup>2,5</sup> · Fábio José Bechara Sanchez<sup>3,5</sup> · Sérgio Henrique Vannucchi Leme de Mattos<sup>4,5</sup>

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## Abstract

Even with all the progress that humankind has achieved in the twenty-first century, the challenge of better knowledge available from science to address our most relevant problems remains. In this paper, we report on a few outstanding references built by the future vision of the great inspiring mind of Professor Sérgio Mascarenhas Oliveira. This special edition of the *Brazilian Journal of Physics*, “Sergio Mascarenhas—a Polymath in Physics,” reports most of his contributions. We focus on his invariant attitude of choosing to understand simple facts based on the best knowledge, going beyond the traditional approaches. For him, the subject did not matter. He systematically sought the knowledge frontier available, contacting researchers of different domains, sharing and exchanging knowledge to satisfy his curious and empathic mind. To illustrate his impact on society, one ought to consider his scientific heritage as over two thousand intellectual descendants that help us to understand his legacy. We conclude this report by describing the newborn Institute of Advanced and Strategic Studies, based on UFSCar, that aims to cultivate a world connecting and sharing the best knowledge available, which are values that had guided our Polymath until his last days.

**Keywords** Future · Advanced studies · Complexity · Collective Intelligence · Strategic · Education

✉ Paulo César de Camargo  
decamargoc@df.ufscar.br

Roberto Antonio Martins  
ram@ufscar.br

Fábio José Bechara Sanchez  
fabio.sanchez@ufscar.br

Sérgio Henrique Vannucchi Leme de Mattos  
sergiomattos@ufscar.br

<sup>1</sup> Physics Department, Federal University of São Carlos (UFSCar), Rod. Washington Luis, km 235, São Carlos, SP, CEP 13565-905, Brazil

<sup>2</sup> Department of Industrial Engineering, Federal University of São Carlos (UFSCar), Rod. Washington Luis, km 235, São Carlos, SP, CEP 13565-905, Brazil

<sup>3</sup> Department of Sociology, Federal University of São Carlos (UFSCar), Rod. Washington Luis, km 235, São Carlos, SP, CEP 13565-905, Brazil

<sup>4</sup> Environmental Complex Systems Laboratory, Department of Hydrobiology, Biological and Health Sciences Center, Federal University of São Carlos (UFSCar), Rod. Washington Luis, km 235, São Carlos, SP, CEP 13565-905, Brazil

<sup>5</sup> Institute of Advanced and Strategic Studies - IEAE, Federal University of São Carlos (UFSCar), Rod. Washington Luis, km 235, São Carlos, SP, CEP 13565-905, Brazil

## 1 Introduction

Among all greatly deserved recognitions of our dear Professor Sérgio Mascarenhas Oliveira (SMO), we decided to prioritize his intangible attitudes as a reference to establish knowledge values within our society. This brief report on the relevance of his attitudes beyond many specific contributions aims to call the attention of our community to the enviable bequest built by Mascarenhas starting a scientific career in São Carlos, SP, in the 1950s, causing a great impact on building a productive and insightful environment for Brazilian research and culture [1, 2].

SMO’s career is evidence of his belief in a better future, based on the best of human creativity and generosity, provided that the scientific method is the reference to make decisions. The Mascarenhas family arrived in São Carlos, foreseeing that Solid State Physics was the best opportunity for new research groups to contribute effectively to the advances in Science and Technology in Brazil. Until the 1960s, advanced research in Brazil was mostly limited to theoretical physics and focused on relativity, particle physics, and nuclear physics [3]. Contrasting with traditional research,

they started to build simple experimental facilities to be able to conduct relevant applied and theoretical research at the frontiers of knowledge. Under the supervision of Professor Joaquim da Costa Ribeiro at the University of Brazil (now Federal University of Rio de Janeiro) [4], using very simple facilities and building models to explain the experimental results on the thermoelectric effects opened opportunities for SMO. He debated his research with famous physicists, such as Richard Feynman and Robert Oppenheimer, among others, during their visit to Rio de Janeiro (1950s and 1960s). Later, he kept exchanging experiences, ideas, and knowledge with the best scientific centers worldwide, learning and stimulating young people to build new, good-quality research groups to satisfy their curiosity and/or realize their dreams [5].

The careful effort to keep a permanent connection with the best knowledge available is clear in the partnership of Mascarenhas with Abdus Salam in Trieste, Italy, and his effective collaboration as a visiting scholar in the USA, Mexico, Europe, and Japan [2]. Due to his experience abroad, the local community had contact with distinguished visitors, including researchers from advanced industrial laboratories such as RCA and Bell Labs.

One of the best pieces of evidence of Mascarenhas' contribution can be realized by looking at the more than two thousand intellectual descendants based only on the Lattes CNPq database (Personal communication, Jesús P. Menna-Chalco UFABC) using reference [6].

Beyond the well-documented contributions of our dear professor Mascarenhas, we have selected his inspiring contributions for the new initiative being implemented in UFS-Car, the Institute of Advanced and Strategic Studies-IEAE/UFSCar.

In addition to his inspiration and enthusiasm for the initiative, SMO helped with some conceptual background, particularly in the conceptual background of collective intelligence.

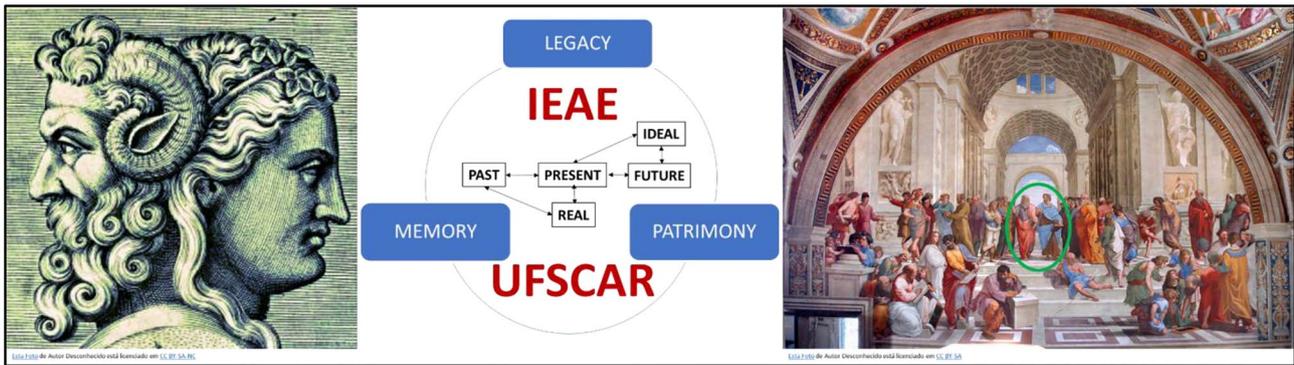
Discussing the challenges of the twenty-first century, SMO emphasized complex systems: the Internet, big data, brain, mind and machine, globalization, alternative energies, climatic changes, sustainability, knowledge revolution, and third culture. When someone asked him how anyone can be so capable in so many different areas, he used to answer "I do not know too many things, but I have learned to identify proper questions, select sound answers, and promising scientific minds to share ideas with." Therefore, his scientific approach always followed the concept of collective intelligence, similar to the methods followed at the Center of Collective Intelligence of MIT ([cci.mit.edu](http://cci.mit.edu)) [7].

One of the leading intellectuals of collective intelligence is Pierre Levy, with the concepts of cyberspace focused on building a new culture with the best use of technology, algorithms, and digital resources. P. Levy collective intelligence [8] presents evidence of our society becoming increasingly knowledge-dependent on our collective ability, becom-

ing vital to understanding how we can expand collective intelligence to provide the keys for a wiser modern society. Different domains share relevant concepts, computational tools, and mathematical methods recalling the relevance of human well-being. The Materials Genome Initiative states "Advanced materials are essential to economic security, and human well-being addressing challenges in clean energy, national security, and human welfare [9], brings human needs to the center of most relevant questions." Our impressive advances in understanding natural science are now going through a very difficult time due to the limited understanding of life itself, the brain, and especially our planet's evolution. The Nobel Prize in Physics 2021 was awarded "for groundbreaking contributions to our understanding of complex systems." The Royal Swedish Academy of Sciences recognizes that the scientific community demands the best scientific methods applied to global already emergent questions. Half of the prize went to Syukuro Manabe and Klaus Hasselmann, "for the physical modeling of Earth's climate, quantifying variability and reliably predicting global warming," and the other half to Giorgio Parisi "for the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales" [10].

The 2021 Nobel Prize of Physics represents a major contribution to a new and consistent scientific paradigm, as discussed by Thomas S. Kuhn in his book "The Structure of Scientific Revolutions" (1962). Considering our present time and following Kuhn's statements, "political revolutions start with a restricted political community having a growing feeling that existing institutions are no longer responding properly." As Kuhn noted, both feelings in the scientific and political communities are due to the presence of defects that can lead to a crisis and are a precondition for a revolution.

Looking for references to guide us at IEAE/UFSCar, we recall that SMO frequently mentioned the mythological god with two faces Janus, with Janus Clusius looking to the past closing a paradigm of traditional science, and Janus Patulcius, opening our mind to a new paradigm, a new normal science (Fig. 1) [11]. The paradigm of complexity shall follow the same trends of past scientific revolutions so that a better and more general understanding of our world reveals previous limitations, proposing broader, more exact, and precise explanations that are able to predict systems evolution, as cited by E. Morin [12]. Complex analytical modeling must consider the system as a whole. The decomposition of the system into complementary parts allows a detailed analysis of the constituents and the network of interactions. An integrated process of data and information analysis allows us to investigate the dynamics of the chosen properties of the system. Metaphorically, one can recall that opposing faces of Janus share the same brain, joining a continuous process well represented by the Moebius strip with no opposing faces, picturing a continuous, infinite process as it is the scientific evolution.



**Fig. 1** The mythological double face god Janus and the fresco of the Athenas School, both frequently used by SMO. Between the images, there are key words associating the images with our Institute of Advanced and Strategic Studies-IEAE and UFSCar

## 2 SMO and the Institute at the Federal University of São Carlos

In 2015, Professor Adilson J. A. de Oliveira, then Vice Dean of UFSCar, proposed that the Multiuser Laboratories for Strategic and Advanced Studies Complex (COLMEEA), a FINEP project with a building already under construction, be thought of as the Head Quarter of our Institute of Advanced Studies, now called the Institute of Advanced and Strategic Studies (IEAE-UFSCar).

A working group of nine well-recognized scientists was nominated by the UFSCar administration, namely, Sergio Mascarenhas Oliveira, Polymath; Wolfgang Leo Maar, Philosophy; Deisy das Graças de Souza, Psychology; Odete Rocha, Biological Science; Heloisa Sobreiro Selistre de Araujo, Physiology; José Eduardo dos Santos, Hydrobiology; Tânia de Fátima Salvini, Physiotherapy; Edson Roberto Leite, Materials Science and Chemistry, to discuss and propose a new concept for our Institute of Advanced Studies under the coordination of Paulo César de Camargo-Physics.

Guided by the concepts of complexity and collective intelligence, our IEAE/UFSCar proposes to follow the structure of the holon. The term “holon” was introduced by Koestler [13] exploring the apparent contradiction within one system where parts represent the whole at the same time, as the whole represents any part. This idea is well represented by a simple hologram picture. A hologram is produced by imprinting the interference fringes of two coherent light beams; the first beam illuminates an object to be imaged, and the second beam is used as a reference. When the figure of interference is recorded on a picture film, the fringes of interference can be used to reconstruct a 3-D image of the object. The entire image of the object can be reconstructed, illuminating the whole recorded film or any part having the recorded fringes. This means that parts of the film, with recorded fringes, contain the same image as the whole film.

Returning to the IEAE/UFSCar, we have chosen to follow the holarchical structure, guided by both concepts: “Holon” and the so-called Janus Principle, pointing out that the dichotomy between the condition of the whole and condition of its parts, or autonomy and dependence, is inherent in hierarchical order. The dynamic expresses a polarity of two tendencies: one self-assertive and the other interrogative. Koestler [13] also mentions the pathology of the disorder hierarchy, caused by competition among holons and recalling Janus he explains: “Under normal conditions, however, an organism or social body is working properly the integrative tendencies and auto affirmative finding a dynamic equilibrium state, represented by Janus Patulcius (The Opener), with the key in the left hand and Janus Clusius (The Closer) careful guardian of the portal, with a stick in the right hand” [13].

Finally, the promising intellectual environment where the IEAE/UFSCar has emerged as a new holarchic organization is briefly described next. The operational part of our IEAE is founded on elements and processes at the same organization level or holon, represented by the TWG-Thematic Working Groups, as well as the WF-Working Fronts in lower levels. At higher levels, there is the Coordination of the TWGs. All these operational parts are planned to interact dynamically, establishing common goals, having an excellent communication system, and following a few well-understood behavior guidelines. The governance of the administration includes the Academic Coordination composed by the Directory, the Coordination of Strategies, the Coordination of Resources, and the Coordination of the TWGs. At the highest level is the Council of the Institute, including members external to UFSCar.

The recognition of elements and processes at each holarchical level and its correlations represent a set of complex nested systems, forming the operational IEAE, which is expected to be competent to plan, execute, evaluate, and adapt itself to different evolving environments.

There is already a promising environment characterized by the following:

- The multicampus structure of UFSCar with our challenges to identify the best new goals promoting an effective interaction among the already established facilities and competencies within UFSCar, including the external communities;

- An increase in communication facilities and methods to select relevant and reliable information is expected to help us establish the complexity and collective intelligence view and methods, therefore breaking traditional restrictions, cultural, and bureaucratic.

- The TWG-Thematic Working Groups guidelines are expected to help favor and promote open interactions, based on the holarchical concept, following a rhizomatic evolution with independent initiatives occurring in different granularities.

- Transforming the Sábato 2-D triangle (Government, Science, Industry) [3] into a Mascarenhas 3-D tetrahedron that includes the third sector to consider global ethics and social and environmental sustainability.

Finally, we shall emphasize that the TWG-Thematic Working Group shall operate within the Internal Regulation approved by UFSCar University Council—ConsUni n°51/2021.

### 3 Conclusion

We were greatly benefited by the “young” and creative 87-year-old mind of SMO, revealing his stimulating mind and ability to handle the best of the knowledge and methods available. Recalling the strikingly different scenarios, comparing 1958, when the Mascarenhas couple first arrived in São Carlos [2], to 2015, when this city was already recognized as Brazilian Capital of Technology (Federal Law 12.504 of October/11/2011), the invariant attitudes of SMO are worth noting, which are always highly flexible and open to understanding the dynamics of the emerging scientific and social environment. He kept the consistency of the scientific method in light of facts and strong belief in the best knowledge available guided by scientific evidence.

Inspired by those SMO values, perspectives, and attitudes, we hope to build the IEAE at UFSCar.

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### Declarations

**Conflict of Interest** The authors declare no competing interests.

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