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Some Aspects of Research Work: A View from Engineering and Creativity

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ABSTRACT

Based on the work done in collaborative projects between universities and engineering companies in which the authors have worked, a series of experiences have been accumulated and recalled, regarding how an engineering viewpoint can enrich the scientific work, facilitating the achievement of objectives, complementing data analysis techniques and accelerating processes. This article describes various of these aspects, with the idea of systematizing the experience and presenting it to the working groups that develop research projects, especially in the field of applied research. Emphasis is given to feedback and loops in the work. The importance of an analytical point of view as the foundation of experimental work: logical reasoning beyond procedures is discussed, plus a recognition of the significance of the boundaries of the research and of a systemic approach to for measurement, calibration and analysis of deviations. A discussion of the state of the art and its relations as tools for searching for information and analytical capabilities is presented as well as a discussion on calculation-based prediction capacity. The role of mentorship, for criticism, reviews and proposing challenges is analyzed. Also, the importance of writing reports, spreading knowledge, establishing connections and stimulating creativity.

INTRODUCTION

Research work is vital in the transitions to modernity, having enabled the development of science and technology. Engineering feeds on different scientific and technological developments. As in any relational process, it is very important to establish feedback loops in the research process, which have the virtue of generating synergies and suggesting new paths and alternatives. Figure 1A describe this feedback concept, by means of work steps that answer three fundamental questions when a search process is being carried out: what is to be found? What has it been found? And, what really happened? A set of work cycles appear to answer these questions, which refine the products obtained, until getting to a result, which can also be summarized in three essential answers: The description of what has been studied in all its relevant aspects; the resulting novelties and discoveries after the study has been carried out; and the resulting paradigm shifts, including the possibilities of application of the research for the progress and well-being of society. Engineering, as a process technology, has a lot to contribute to the various mental, experimental and emotional processes that result in these questioning and finding cycles that generate the answers. Asking and responding are, above all, communication and active listening processes, that work much better when considering feedback cycles as the ones outlined in the figure 1B. This has been intentionally shown which many connections between the elements (questions and answers), that go in both directions, in addition, to indicate that several loops or cycles are generated, to show the highly interconnected nature of the process. [6-7]

Because of this complexity, different possibilities surge, establishing a broad strategic spectrum, rich in opportunities and risks, which in turn generates capacities and strengths and exposes existing weaknesses. As descriptions are generated, innovations are discovered, and new interpretations are raised, the process being so enriched. Knowledge and science flourish. In many ways this is very similar to what happens in production systems, and in the field of technology and applications. Engineering, economics and human well-being flourish in these fields. As long as the limits imposed by nature, environment, sustainability and humanism are respected, these are fascinating and enriching processes [1]. Given the similarities between the two fields, knowledge and application, it is useful to establish relationships and connections between engineering and research. Thus, there will be flows of good economy, of applicability, of prosperity towards the scientific field and of science and

knowledge towards the field of the applications. The present work discusses some of these aspects in order to enrich these interactions.

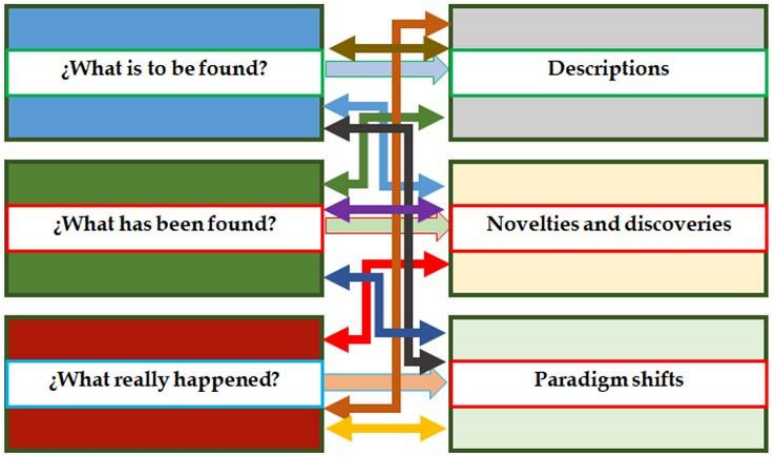

Figure 1A Question and answer cycles

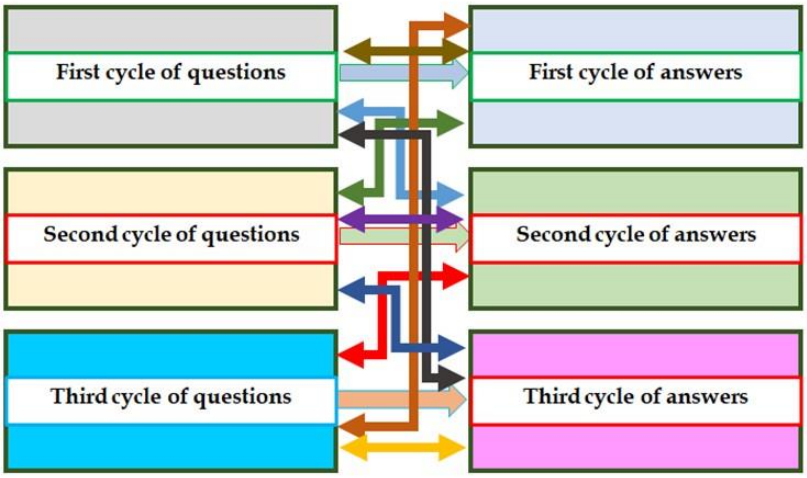

Figure 1B Loop of Cycles of questions and Answers

The analytical point of view as the foundation of experimental work: logical reasoning beyond procedures

Given the high complexity of experimental work and the great abundance of methods available to solve characterization and identification problems and the wide range of variables to study, it is normal to generate very large amounts of data [14]. Given this situation, it is customary to follow procedures already established or to introduce new procedures, to facilitate an orderly, verifiable, reproducible work that can be easily reported

to peers and colleagues. These data sets are the basic result of experimental perspective. Through their analysis, it is possible to refine the work and eventually to reach important conclusions and to find novelties, potential discoveries and new knowledge.

Notwithstanding the foregoing, it can take a lot of time in the planning, in the execution of many sets of experiments and in information analysis, without really getting to see the results that allow for the understanding and refinement of the phenomenon, process or system in question [16]. Here it is proposed to focus work taking into considerations an initial analysis and some previous reflections, trying to understand the influential variables and their effects, based on established laws and prior experimentation. This facilitates the visualization of the phenomena, establishing cycles and analysis interventions prior to experimental work and during the same, including reviews and possible improvements in procedures. Figure 2 describes this idea. It shows a richness of interactions between the processes of analysis, the processes of experimentation and the procedures themselves. It can be guaranteed, in most cases, that in this way, the research process is accelerated, and objectives can be attained with greater speed and with a more holistic view of the phenomena studied.

One of the greatest advantages of the use of logical reasoning and analysis is that it obliges to consider the theoretical aspects and the impacts of existing laws on the experimentation, facilitating a better definition of the ranges of work and contributing to a deeper analysis [8]. In addition, important elements are prevented from being passed over, elements that could change the focus and the ways of executing the analysis at all levels. With the use of computational and simulation tools, the developing of these previews and perspectives is facilitated. In general, however, there is the risk of decoupling the computational analysis from the laws that control real behavior, so it is advisable to develop analytical models in parallel that allow to review the computational results, achieve greater certainty, improve the work and experience more coherence.

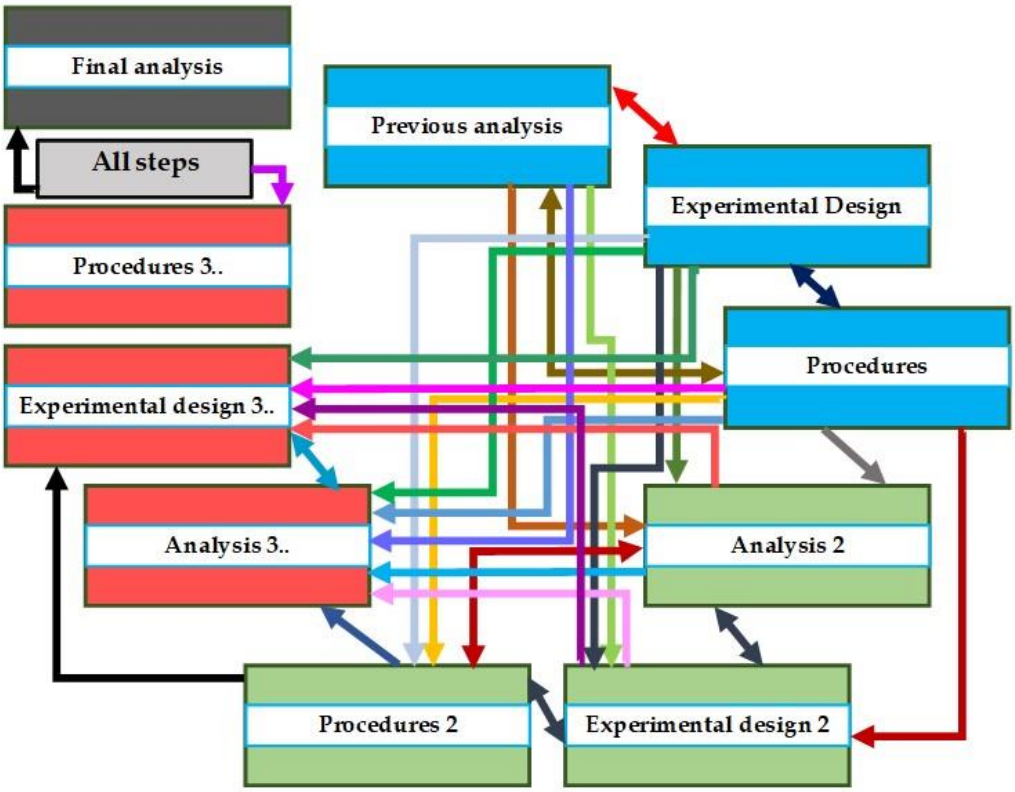

Figure 2 Loop of cycles of analysis and experimental phases

Understanding and knowledge of system boundaries.

When talking about the boundaries of a system [10], there are several definitions that can be applied, such as the following:

- Unknown areas, in which you can lose control of the operations, increasing the risks and weaknesses, which can help make things go wrong. With the study of these zones, opportunities or transformations that affect other areas are also generated.

- Expansion zones, which can facilitate the growth of the projects and their extension.

- Border areas, to which limiting conditions affecting behavior are applied.

- Areas of contact with other projects. These areas also represent the ability to interact with other researchers and previous experiences. These areas are related to expansion zones.

- Observation areas, from which researchers can position themselves to appreciate projects from other points of view. In this way, they can contribute generating the enrichment and

coverage of the zones. External observers can be invited, and their perspective could point out unattended areas that should be considered.

- Areas of change, from which disturbances and opportunities are generated.

Setting limits is an analytical and contemplative task that is based on the descriptive and observational capacities of observers, which are developed as they move away from the center of the project [17]. Moving from the center to the limits implies communication efforts and sensorial focusing. Moving from the limits (or from an external zone) to the inside of the project implies activities of approaching, identification with it and attention to detail.

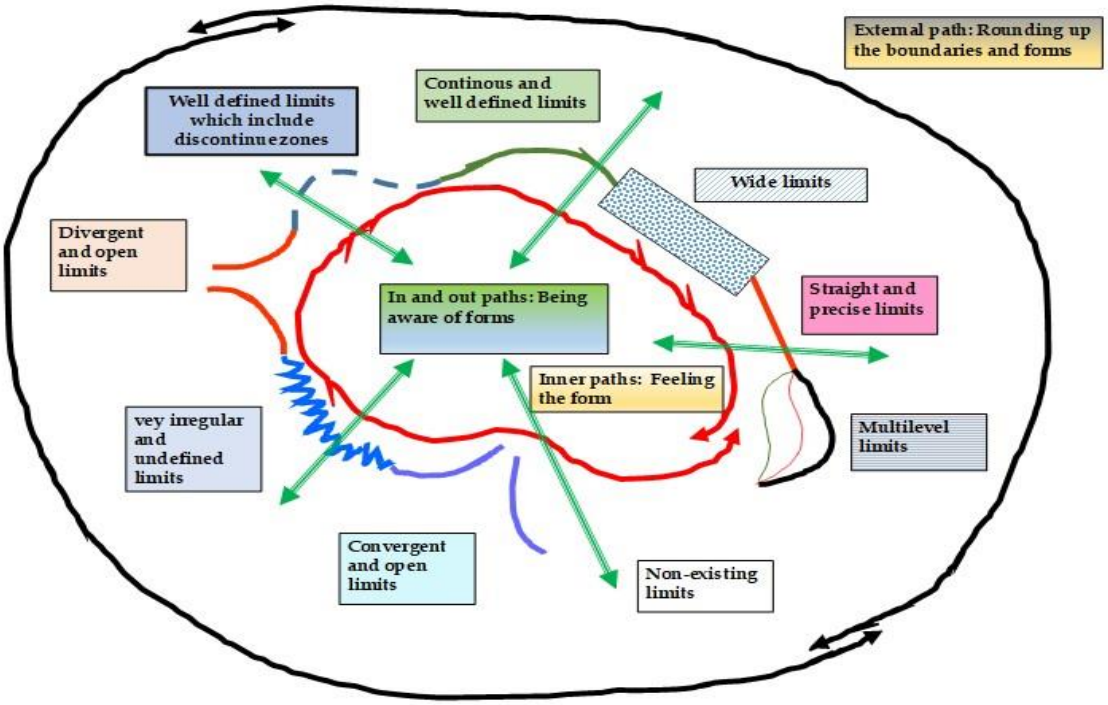

Figure 3 Explorations and recognition of boundaries: definitions of forms

By recognizing the limits and extending to them, relational and contact skills are developed, which will benefit and strengthen the project. On many occasions, this gives rise to experiences of realism, acceptance or rethinking. This is a work of a recurring nature that is part of what has been described in the previous considerations. Figure 3 outlines some of these potentials, which are described as movements of the researchers which define the forms or boundaries of the project.

Establishment of systems for measurement, calibration and analysis of deviations.

Naturally, research being a set of explorations of reality, with the goal of knowing and determining, hopefully predictably, its behavior, it manifests itself as something hidden and undefined, by means of signals and information. These are, generally abundant and correlated. Frequently, their interpretation can lead to many difficulties and distortions when compared to the objective reality that the observers want to experience, to describe and to know and understand [18].

The determination of something (this is to say, where it ends, how far it goes) is based on the identification and categorization of functioning and characterization variables (those that give the character to the object) by means of measuring systems. The signals are transforms of the hidden reality, which at the same time manifest themselves as elements that can be measured in a reproducible way. As the typical thing is that everything is related to everything, the manifestation of an effect gives rise to many signals, being important to isolate and purify some of them, those which are considered indicative of what the observer wants to characterize or to measure.

Distinguish and purifying signals are research actions of the utmost importance and although the field has been enriched with multiple instruments and techniques, it is worthwhile seeking that the research process also contributes in this sense, finding new signals and new ways of measuring them with objectivity. The different techniques are used also as verification and complementary tools. In general, a given technique does not provide the total information of the phenomenon, it gives partial information that should be analyzed by the investigators [19]. With good criterion and creativity, they reach findings and propose new questions that permit deepening and improving the studies. Here, curiosity is a key point.

It is worthwhile to ask questions and assume challenges related to possible alternative methods of measurement, getting even to the point of their development and verification.

The importance of calibration should be stressed. Even if the researchers have specific and proven methods that allow them to determine the variable values, parallel routines and alternative determinations should always be established in order to get closer to the true measure of something and to the inherent error of equipment and measurements. Even if they have the most sophisticated measurement techniques, calibration must be performed, to ensure the reliability and reproducibility of the measurement process. Calibrating has a

classical meaning, which consists of comparing measurements and methods against patterns established for the behavior of the variable, establishing the so-called calibration curves. They show standardized patterns, with known behaviors as function of changes in the variable to be determined. It is often a matter of working with linear behaviors, which allow interpolation and sometimes extrapolation. Calibration curves facilitate several results:

- To go through the procedures and get some training and experimental mastery. The curve itself is an evaluation system for people being trained. At the same time, establishing new calibration curves allows for greater mastery in experienced people.

- To understand aspects related to the purity of the signals and their noises. Deviations provide information of great value and should not be summarily dismissed using approximations, but also understood either as components of complex systems that are interacting or as aspects to be studied and that correspond to actual operational points of the variable being measured.

- Approaching non-linear behaviors, whether they occur outside the range of calibration or as disturbances within the range, which may indicate new phenomena worth studying.

In addition to calibration curves, procedures must be provided to ensure the quality of what is being done. Quality deviation could occur for multiple reasons:

- Malfunctioning of the equipment being used.
- Deviations in the steps of the procedures.
- External and circumstantial factors
- Presence of impurities
- Loss of records and registers
- Lack of capacity of element of the measuring and experimental systems.

Establishing a statistical and regular calibration system is a good practice. The determination of standard deviations and their comparison with specified working ranges, determining capacity and centering indices, is an excellent tool to normalize processes and to achieve experimental discipline and ensure reproducibility in the studies.

Introducing on purpose, experimental drills and known disturbances, in order to observe and calibrate how the work teams respond and whether or not their members are able to overcome the situations and report the disturbances, can help to calibrate the methods and to give tranquility and trust. This can be done not only from the experimental point of view but also from risk analysis considerations, by means of questions and answers at work team meetings. This is also part of the safety analysis of system and of their knowledge. In this sense, several investigators must know their functioning, limits and be familiar with the main elements that guarantee the operation within the parameters of calibration and normal operation. Ideally, systems should be instrumented to recognize abnormal variations, this allows greater safety and reliability.

State of the art and its relations as tools for searching for information and analytical capabilities

The state of the art refers to the highest level of development achieved at a certain time in relationship to any apparatus, technique or scientific field. The word art has a deep, aesthetic, beauty-related sense. Fine arts are the most sublime and elevated arts. When it comes to art at its highest levels, one thinks of two characters of the Italian Renaissance, Michelangelo and Leonardo da Vinci. Both stood out for being integral human beings, with far reaching interests. Michelangelo was a painter, sculptor, builder, designer and poet. Leonardo was a painter, anatomist, designer, engineer, inventor, philosopher and theorist, writer and builder.

This artistic aspect, that is to say, what relates to art, implies an ample use of human possibilities. The state of the art should include the respectful use of resources, elegant and aesthetic design, ergonomics and respect for people, sustainability. All of this in relationship to work and in the objectives, quality, productivity, ease of operation and efficiency. All this within costs that allow for its application. This far reaching goals seem a lot like utopias, great challenges, but are very important.

Trying to approach the state of the art is important because it extends the vision of what can be achieved, increases the knowledge of the new advances in equipment, measuring systems and procedures. The state of art is also a recognition of the work of others, it is to assess the previous analysis, is to get away from merely ego-based viewpoints, that could cause difficulties. It is to broaden the perspective and to have the ability to find globally what has

been done and how it has been done, is communicating with others and keeping learning and attention open to external wisdom [15].

When the progress towards the state of the art is examined in depth, the following elements appear:

To have an intention. This is a decision-making process. Involves selecting an object or a system deliberately as an element on which work is to be done. A whole series of events is generated with this intention.

Observing chosen aspects or elements in the object. This is a detailed knowledge process. It involves taking time to observe data and documents, to relate to something and find similarities with elements that are not necessarily part of the initial field of study.

Set work limits. Define and delimit. This is a process of observing and defining the work scope and the space occupied by the object that is going to be studied.

Intimate and empathetic approach to the system. Identifying with the object. Going deeper into its details and the internal realities. To get motivated. To became sensible and to feel stimulus. To appreciate and give feedback.

Expansion and change of level. Changes are proposed, negotiated and accepted. New levels are assessed and reached.

Elimination of less favorable practices. The decision is made to change aspects that do not contribute to the achievement of the state of the art, recognizing that they can be changed by better practices and that there are capacities to assume and enjoy the change.

Adoption of new practices. To start working and enjoying the new, better results and aspects.

Celebration. Success is shared with everyone involved. It is recognized as the result of team efforts and contributions.

Feedback. The previous cycle is repeated until it becomes the state of the art, as much as possible.

The search for the state of art implies establishing relationships. As this name implies, it is supposed that there are places in which the respective art is dominated, either due to experience, to tradition, technology, economic capacities; because of having networks of suppliers of science and technology or due to the existence of an advanced ecosystem.

From a more analytical point of view, one can say that there is an underlying **ideal state of behavior theory**, which gives ground to the work that is being done. To know and describe this state implies having basic knowledge about the processes being developed, about the principles of conservation of mass and energy and about the constraints and limiting natural laws. In this way, it is possible to describe and know the limits that can be reached when the situation is carried to idealized, reversible and totally optimized and productive working spaces. Of course, this state comprises a whole range, ranging from having knowledge of improved work points and of idealized viewpoints.

In considering these pursuits of excellence, it is worth examining the history associated with the topic being developed. By observing any historical milestones, what is done is to describe the situation as it is today, as it has been in the past, both from the positive and the negative aspects. This includes the sets of data and records that exist, the reports, articles, books and publications that have been written. Here, it is worth considering the great challenges that the different working groups have been trying to solve the challenges and to examine to what extent all this becomes part of the community of giants on whose shoulders we stand.

In some way, when examining the state of art, there is a call to propose modeled states and simulations. When looking at the system from the point of view of modeling, what is done is to subject it to simulations and tests, through various techniques, to examine how it responds to possible variations. This is done to convene simulations and experiences associated with the state of the art, based on deliberate experiments and guided by the existing wisdom. Simulations can be carried out using calculation models, which is facilitated by employing computational tools. Trying to approach the state of the art also allows to calibrate the simulations and to understand whether the models should be refined, or other parameters should be included.

It is worth emphasizing that when talking about the state of art, a wide spectrum of possibilities in the development of human skills are considered. This includes the entire field of mind and body, from the creative to the intellectual, with all the emotional and physical

aspects, integrating this whole into the practice of valuable skills for the human being. The development of art implies a constant, evolutionary, systematic work, in such a way that a body of ideas, methods, wisdom and right practical knowledge is structured.

This work does not stop. It is continually being refining and perfected. In each issue or theme, there are lots of people and institutions that make contributions. There are many institutions, universities, companies and people highly committed to the improvement of systems. With all these contributions, an increasingly elegant and coherent body is being shaped, which can be called the state of the art of the research work in a given field.

To locate this state of the art, all researchers and developers have the fortune of being part of a great universal system, rich in relationships. For this reason, they should not be isolated because they would be losing opportunities and competitiveness. Technological change and research development tend to be very accelerated and it is important to be aware of things that happen. In this ecosystem, equipment suppliers are vital. To be close to the state of the art, of course, is facilitated by maintaining contacts with the equipment suppliers. This is one of the most direct routes in that direction.

Technologies and research that mature are reflected in commercially available equipment, which can take several years to be developed, but eventually, this mean to have available offers and suppliers. It is wise to frequently invite equipment suppliers to the research working groups so that they have the opportunity to present their innovations and sharing their experiences. Similarly, contact with suppliers is also a source of ideas and joint work. Developments can be supported in the experiences of these suppliers, in the requirements of the market and in the regulation and normative demands.

Calculation and prediction capacity

The research work tends to be based extensively on the use of experimental tools, in which a systematic space of operation is covered, following established protocols, up to the point of discovering desirable operating points. Despite this, methods and protocols can be refined, involving calculation and prediction tools, in order to achieve a faster and more accurate approach to the desired operating areas. The following is a list of possible approximation schemes [20].

Assume that a solution has been reached and take it as an established one, finishing the process. If, in fact, the process has already come to the desired point, it is a good decision to clarify and declare this, which, anyway, must be done sometime. But assuming this can happen for a variety of reasons, without necessarily having reached the essential truth: because of time or resource constraints, because of directions being given, because of exhaustion of attention and saturation and fatigue of the experimenters, among other. From other point of view, it is always worthwhile to sensitize the variables and move near the solutions found, to ensure the results and determine that there are not unexpected angles and perspectives, which could generate even better accomplishments. Curiosity and proactivity are essential to make sure assumptions are based in real facts, to be open to question and to continue energetically in the search of the desired solution.

Moving in a given direction, little by little, by successive approximations. In this approach, it is worthwhile to have criteria to select a range of working directions and be able to use, at the beginning, faster approximations, before refining the work through detailed and fine approximations. If the work comprises a very wide range of possibilities, working only by successive approximations based on fixed intervals can be very laborious and inefficient. On the other hand, successive approximations distanced by small intervals allow to fine tuning and delimiting the procedures, determining inaccuracies and errors. This method of work should be supplemented by real time result observations, in order to project and predict behaviors in the areas neighboring the solution zone.

Move more broadly, looking for major changes. In this way, broad and quick realizations about the location of the desired working zones can be reached. Working between extremes based on medium intervals, which then become new endpoints of the following steps and trials, is one of these approximations. Sometimes the variables can be moved with greater freedom, in such a way that observers are able to see oscillating and opposite behaviors, which reveal the existence of a desired point within the studied areas. To be able do this, more dominion, autonomy and knowledge of the process is required, than in the case of successive approximations. This method can be combined with that of successive approximations, which is equivalent to initially finding the field that produces the best results and then move through it in a more moderate way, to understand its functioning and sensitivity.

Move using predictive tools. This can be done by taking advantage of the available experimental information which encodes the behaviors resulting from the effect of the variations. In this way of advancing, known working points are projected towards new ones, based on the observed variations. This requires a good knowledge, not only of the behavior of the variables but of the impacts of their variations, that is, of the changes of their functions against the tested variables. What in that the strategic working groups do is to apply these accelerated working methods, understanding the meaning of the variations as information on change to find the new operating points.

Organic understanding of the performances.

The laws of nature in their general aspects (those that always apply) and in their constituent aspects (those which apply specifically to classes of substances or phenomena or to particular areas of operation) allow to observe with physical sense, with organic vision, the performances. What is proposed is to apply essential and fundamental knowledge to phenomena, observing their objects as bodies that respond to structures interrelated and connected by existing laws.

When descriptions are made prior to experimental work or when descriptions are made between experimental works and stages, organic understanding is facilitated. Similarly, this happens when graphic diagrams and descriptions are made and when observations are put in context in relation to other phenomena or realities [9]. Also, when proposing mental experiments and analogies. The deliberate selection of laws already established and their application to experimental data or to the new phenomenon contributes to illuminating the field of work and defining it. Figure 4 outlines these concepts.

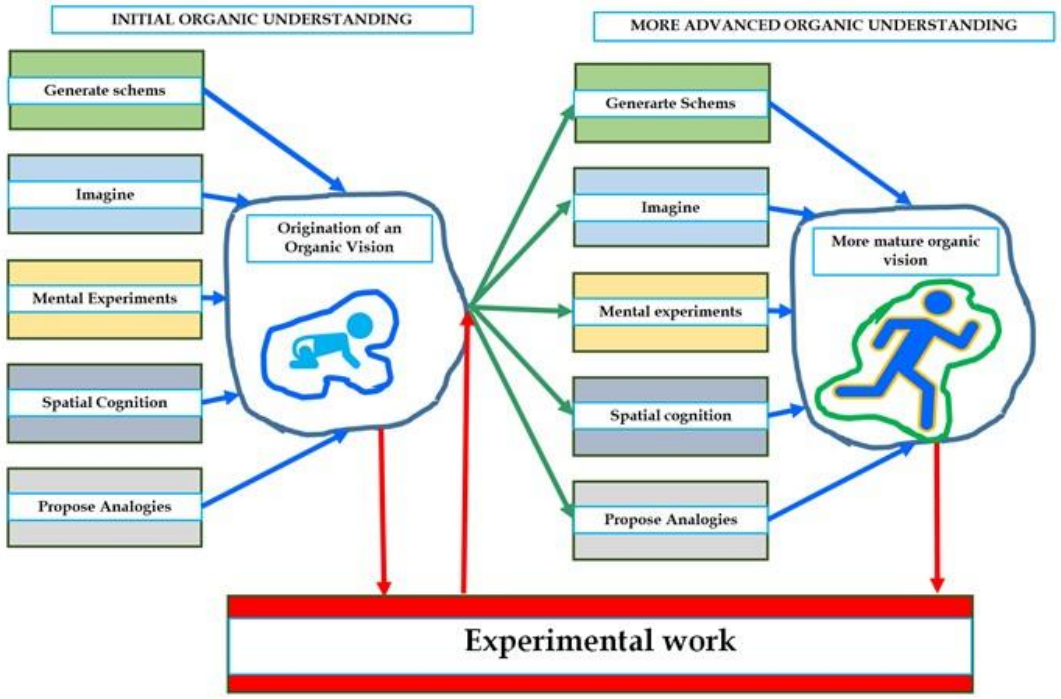

Figure 4 Stages of organic compression of phenomena as a complement to experimental work

Integral characterization that contributes to structure the concepts

The current analytical methods, increasingly sophisticated, provide a wealth of information, which goes beyond the data obtained. However, the very complex nature of the results and the relative abundance of methods used, makes the researcher's attention more focused on the data, without giving enough attention to the information that accompanies it. The data sought can be reached in different ways, but what gives richness and advancements is the understanding and analysis of the information.

It is convenient to explore as much as possible the complete nature of the information received or reported experimentally, trying to take advantage not only of data but also of the complementary information. Here we propose several principles that underline this: the part is related to the whole and the whole with the part; there are several levels in the observed reality, which are manifested in the data and in the complementary information; the details are important, even in the case of circumstantial information and small elements; measuring something reliably, implies exploring the circumstances surrounding the measurements.

Ideally, people in the group should be able to understand all the experimental information generated, putting at the service of the project these capacities to have a structured and

integral vision of the experimental work. As operation, measurement and characterization systems are developed, it is important and inevitable that specialties are generated. However, observers should always have a holistic vision, and the working team should be oriented so that the specialties increase the efficiency of the work and bring more skills in the finding of solutions.

Review that goes beyond quality assurance

Work reviews should be done from different points of view. Not only from the point of view of ensuring correct procedural work, but also trying to establish parallel routes of observation that allow for the organic understanding of phenomena, for creative developments in the interpretations, for more capacity to interact with other experts and for autonomy in the conclusions.

Revisions are critical procedures in which three observation possibilities are considered in relation to objects: what is observed directly; what is hidden; what could be.

When reviewing using the first possibility, the vision is refined, the observer pays attention to new details, integrating the details to the analysis, being conscious of the consistence between observations and interpretations, ensuring that the whole phenomenon gets to be observed and that the data permits to round up the phenomena, tying loose ends and constructing a novel and useful thesis. This view facilitates to find errors in different parts of the process and helps to confirm, repeat or rethink experiments.

When looking for what is hidden, the observers work on questions that need to be answered, removing various layers that could hide methodological, conceptual or interpretation errors. Parallel procedures and experimental repetitions are also used, with the intention of observing not only the data and the procedures but also their variability and the impact that this can have on the intrinsic quality of the study carried out. These questions and these variations seek to make risk and opportunities analysis of the work, exploring additional areas to the ones reported. Frequently this reveals hidden possible inconsistencies or suggests innovations that could be exploited.

By reviewing in search of what could be, what is done is to raise possible changes in the focus of the study, with the aim of achieving greater scope, more applicability, greater depth, possible connections with other studies or fields of knowledge. The results are also

questioned in terms of the level of challenge and novelty that has been achieved, reviewing how real is that objectives have been achieved, trying to reach higher levels of excellence.

These review processes help to develop expertise, making it easier for researchers to become experts in the fields of study. It is desirable to have the accompaniment of consultants and peers with authority and ability to review the work, adding added value when doing so.

Accompaniment by mentors for criticism, reviews and proposing challenges

The points discussed above are completed with the existence of mentoring activities in the research process. It is an established custom that work in research projects includes the presence of project managers, consultants and peers who review, in addition to being subjected to several auditing processes by delegates of the entities that support the projects. Here, however, the concept of mentoring is emphasized as a generous accompaniment of expert people involved in the project with the aim of helping to orient it towards excellence as much as possible [2].

For this to happen, it is convenient that researchers have attentive listening attitudes and appreciation, based on the recognition of the expert, of his mastery and good judgment. Mentors should approach the project and the researchers with empathy and with ability to feel what they are and what they experience and with closeness to the project, considering it as their own one, as a vital matter.

At the same time, contact activities and consultation will have to be established, so that the necessary interventions and interactions are given, and the mentor can examine the work, read reports, observe experimental work, receive and answer questions, make suggestions and draw attention. These instances must be considered as important moments of truth that open the doors of wisdom and learning.

Challenges are important and should be welcome, albeit from a speculative point of view. The pursuit of excellence implies renewing visions and objectives.

To write and to spread knowledge

With the emergence of writing and the invention of printing, there have been continuous exponential growths in knowledge. At an early stage, when signs and pictographic symbols appeared; in a second stage when the alphabets and the ideographic writings were developed;

in a third stage, related to printing and the mass edition of books; currently the digital systems transformed communications. In the future, the systems based on mental waves, in verbal and gestural registers, and in other methods of transmission and structured reception of concepts and ideas will keep an ever-increasing pace of change and evolution in spreading knowledge.

Investigators are witness of their own stages of growth in their capacities to express themselves and to communicate the wonders and discoveries found in their own work. But, quite frequently, desirable transfers and application derived from this knowledge are not communicated, and many ideas and structures that could be applied and divulged, stay, literally in the inkwell. However, in practice, given the very large number of people who investigate and explore the mysterious and hidden aspects of reality, thousands of documents are generated every day, which appear in the hundreds of thousands of journals, books, reports, reviews, web pages and other means of expression that appear annually.

When writing, the investigators are not limited to exposing their knowledge to other ones and to disseminate their findings. When writing, rather, what they do are personal catharsis, explorations of their beings, beliefs, ideas; reflections on themselves and on the world being explored. Writers are composing themselves when they write, painting personal works of art, word by word. They become in this form the words in mirrors of their soul, of their inner being.

From another point of view, it is advisable that investigators be good readers, with capacities for speed, creative, or slow reading, as may be the case. These same capabilities will be useful when writing. The varied capacities of reading and writing reside in the mind of investigators and depend on their views, thoughts and definitions.

When defining themselves as readers and writers, observers and researchers are best served if they try to use their full, integral capabilities. A scheme for this is proposed in the following list of attributes, presented in graphic form in figure 5.

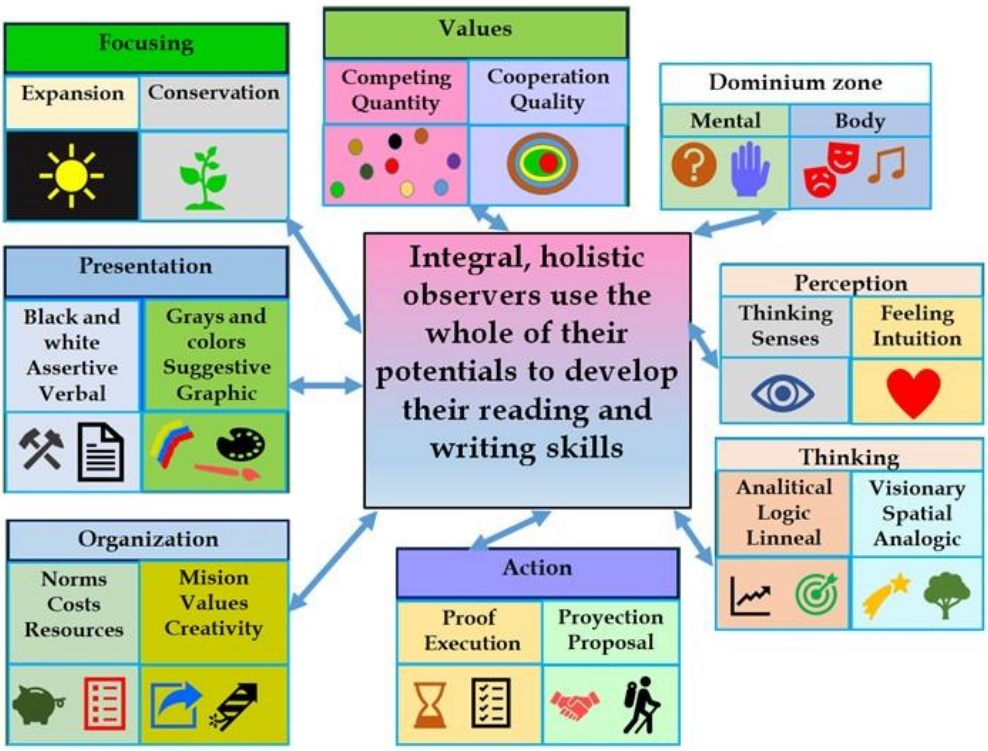

Figure 5 Integral vision of the reading and writing processes

Establishing connections

It is important that researchers feel that they belong to networks of people and entities. A network is a set of unions between elements that confers a special character to these elements. The network generates union. Union generates strength and increases the capacity of the individual elements, which together, as a network, are especially powerful. Networks generate collective and interdependent movements of the elements. Collective movements tend to be unpredictable and surprising and generate a mixture of impulses that are both overflowing and prudent. These movements take into account the different elements and synchronize collective yearnings. Networks generate feelings and empathy. When people are part of a network, they tend to feel and experience what others are feeling, because what the other one feels and experiences, becomes a vibration of the connections of the network and touches the elements so united.

The network generates states of awakening and alert. The individual consciousness and the attention of alert elements, awaken those that are somewhat asleep or unconscious. This lightens the collective and individual evolutions. The network creates a common language that mitigate the effects of name-calling, separating, offending, dividing and paralyzing

tendencies. This helps creating a more harmonious and affectionate language that stimulates collective appreciation and individual wellbeing.

A network of interconnected elements allows for interpolating, extrapolating, projecting, concluding and building a new world. When the connections work as an imaginative network, there are feelings of closeness that stimulate images and new meanings. When the network is creative, daring goals appear as well as new valuable visions and new realities. Projects and ideas are facilitated. Such a network provides observation and appreciation capabilities.

Stimulate Creativity

Creativity could be defined as a capacity to propose alternatives in the development of the different activities of the research process. Creativity is stimulated by imagination, intuition, creation processes and observation [3,5,13].

As the name itself suggest, **Imagination** [12] is awakened and stimulated by working with images. A practical way of generating images is experimenting empathic states of feeling and identification. In this practice, observers deal with objects, people, ideas, with any type of element or situation. They assume different points of view, putting themselves in the place of the objects, persons, ideas, situations, mental states. In this way, they imagine themselves having certain ideas or experiencing certain situations. Doing this, empathy surges and helps to create and to analyze, the observer entering in a search for the understanding of different states, mental and physical [11].

Experiencing feeling and imagination open the eyes and the senses towards states of expanded consciousness, towards art, innovation and inventiveness.

Intuition can be defined as the ability of answering difficult questions, those that do not have yet a clear answer, i.e. the ability to approach the unknown, finding related answers and questions. The research process is, in good part, the design of a fabric of answers to approach the textures of the unknown.

Faced with such questions, the researcher uses a wide range of scientific research methods. Here it is proposed that researchers explore also intuitive approaches and direct them towards the establishment of models, alternatives, creations, through the artifice of proposing and

daring to answer difficult questions related to the research. What can could be sources to find answers to such questions? Everything. Everything can be inspiration and source, every object, all existing ones in nature. Essentially, researchers are beings connected with nature, this abundant source of explanations and behaviors, which could appear as answers, to the extent in which identifications and connections can be stablished, originated on the very nature of observers, as living beings, endowed with all kinds of organs, systems and sensations.

Such connections are part of their intimacy, of their inner light, of their fundamental state of being. They also include concepts and ideas; experiences and dreams; desires and frustrations; consciousness and lack of it. That is present in the self, and when investigators become associated with intentions, connect in many ways, some of them mysterious, with that essential being and its contents, that, in this way, has an opportunity to express itself. Recurring in these processes with confidence and continuity, lubricates and speeds up those contacts.

Asking intuitive questions several times, at least three times, and taking note of the resulting answers, is important. Insistence and persistence are going to help in the realization that these intuitive processes are of recurrent nature, which means that they get improved with practice and with the opportunities that appear.

Intuition opens the eyes to the transcendent and the underlying sense of things, towards the integral vision of the problems. It allows dialogue with nature and is the gateway to the development of special creative faculties that all human beings have in the different fields of life.

The **Creation process** awakens through the projection of observers towards new realities and their work developing projects. Creations surge when they pay attention to any new realities that they want to experience and when they originate personal declarations expressed as existing realities in present time. For this, they consciously choose appropriate words, knowing that they contribute to originate these realities and the desired objectives. Researchers are the creators of their own realities in their own areas of personal domain. Also, the declarations of a group apply to the group domain area.

When expressing these declarations, it is natural to have doubts, experience negative thoughts, difficulties and feelings of helplessness. The lack of time, of resources, of

knowledge, of motivation and other fears and limitations appear almost inevitably when a new reality is expressed.

As a practical answer to these doubts and thoughts, conscious observers and researchers feel the impulse of undertaking some kind of project. It is worth to recognize this call as a particular workspace. Accepting it, assigning a title, which sums up the reality in an attractive way. Assign specific objectives, aligned with the great objectives of research and researchers which contribute to service, to help building a new world, happiness, beauty, peace and universal harmony. Accompany the new creation or project with lists of activities and a work plan that solves the issues of what to do and how to manage time. List the resources required, to be able to work with others, feeling the support of the surrounding world. Proposing projects awakens the thirst for knowledge, gives satisfaction, makes researchers more real, more human and closer to people, expand their areas of domain and those of the groups of which they are part.

Observation is based on the other three creative states mentioned and will awakens by conscious management of attention, which is the fundamental source of creative energy. Attention tends to be attracted and repelled by objects, which causes it to suffer oscillations. Given that, it is proposed as to train attention to be properly focused, refining observing by several practices: recurrence, meditation, concentration and contemplation. **Recurrence** is the ability to oscillate in the use of points of view, alternating several times between paying attention to the desired object and letting the attention slide toward other objects. **Concentration** involves deliberately focusing attention on a given object; When the observers combine recurrence with concentration during a certain time interval, they are practicing **meditation**. When meditation is combined with an intention and with specific objects, as focus of concentration, it becomes **contemplation** [4].

Those attention states described are observational games, in which the observers play with objects in a recurrent way. Eventually, distractions may occur, as the nature of the mind is restless and curious. When observers notice these distractions, they voluntarily can recover the chosen focus for their attention, in a gentile and effortless way, putting their attention, again in the object. When these practices are done regularly, for some time, attention becomes flexible and observers experience states of consciousness that are creative, expanded and beneficial for the development of knowledge, which can serve as support and complement to the normal scientific methods of research.

There are many variations in these recurrent attention games. For example, observers may visit a museum and recursively observe the works of art, or take a walk in a garden or in the countryside or on any path and recursively look for details on the objects around them; or lay on their backs with their eyes to the sky and observe the clouds, or sit on the seashore to watch the waves, or listen to music. or read poetry. Or get carried away by the innocently looking face of a child who plays with his hands in his cradle. Or just for a moment, watch students busy in their homework. Of course, this also includes contemplating the research project and its many edges and variations, as object of observation.

When researcher practice these describe creative actions on a regular basis, hopefully daily, they will feel filled with appreciation and admiration for all that surrounds them. Their mind clears up and wakes up. Time seems to be abundant. An atmosphere of support is everywhere. These are the effects of attentive and appreciative observation.

CONCLUSION

Various tools have been presented, some of them classic and accepted by the scientific community, some perhaps new and creative, which can be considered as somewhat speculative. They are all based on the experience of the authors and have given very good results in their work in search of knowledge and research. The authors feel that the combination of the suggested methods leads to a more holistic, comprehensive and balanced approach to research work.

Of course, this is just an approximation to a rich field, full of challenges. Many other things have to be taken into account. We mention among them:

- Experiencing self-esteem, trust and confidence in all what is done.

- Having an evolving mentality. Feeling that everything can improve, without regard to age, or to the environment that surround the work.

- Completing the work with the help of all the disciplines and supports that are available, especially when doing experimental work. For example, having available a mechanical shop and facilities for the assemblage of devices and instrumentation is quite essential to develop many experimental projects.

- Obtaining generous support in relationship to characterization techniques and equipment, offering, when applicable, the research work to be done with them as a means for calibrating, standardizing and making known the corresponding equipment.

- Timely divulgation and socialization of results and assertive communication are tools that eliminate obstacles and facilitate compliance with objectives and acceptance.

- Availability of right criteria, applied properly, to achieve results within time and cost constraints.

- Learning to deal with administrative duties, requirements and controls.

- Maintaining concentration and focus on the topics of the project, maintaining regularity and discipline in the activities.

- Maintain and secure honesty in the results, traceability and transparency in data management and conclusions.

- Remove fears to be judged and to receive criticism when making disruptive and creative proposals.

- Continually improve in the methodologies to experiment, calculate and analyze.

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