

# Fostering Inter-Disciplinary Communication (FIC)

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## *Abstract*

*The main objectives of this article are 1) to show the importance, even the necessity of inter-disciplinary communication, including its role in avoiding intra-disciplinary intellectual/academic incest and 2) to provide conceptual, notional, and programmatic contexts to the papers published in this special issue.*

*First, we will to show that effective inter-disciplinary communication 1) develops critical thinking, in general, and, more specifically, in intra-disciplinary thinking, supporting more effective intra-disciplinary research, education, and communication, and 2) is a source of creativity via analogical thinking, which generates the analogies required for any kind of logical thinking, e.g., hypothesis formulation in inductive logic, conjectures (e.g., potential theorems) in deductive logic, plausible explications in abductive logic, possible means in ends/means logic, etc.*

*Consequently, effective inter-disciplinary communication is a great support to both intra- and inter-disciplinary research and education, as well as for knowledge integration. It supports, and even it is required in both analytical and synthetical thinking, i.e. in both: knowledge production and knowledge integration. The former is oriented to approach the “truth” (in its different meanings) and the latter is required for the solution real-life problems, at any level: individual, collective, and social levels.*

*This is why the International Institute of Systemics, Cybernetics, and Informatics (IIS) has been since 1995 trying to foster inter-disciplinary communication.*

*This special issue of the Journal of Systemic, Cybernetics, and Informatics (JSCI), entitled “FOR Inter-Disciplinary Communication” is part of a larger program oriented to fostering inter-disciplinary communication, which has been conceived and being designed and implemented, by the IIS via incremental planning (Braybrooke & Lindblom, 1970). The fundamental methodological bases are Action-Design (Callaos N. , Co-Evolutive Action-Design Methodology, 1997), (Callaos & Callaos, 2008) and Action-Learning. (Marquardt, Banks, Cauwelier, & Ng, 2018).*

*This is why we will briefly describe the program FIC in order to provide context for the purpose of this special issue. We will also, briefly, describe other projects in the same program FIC in order to support a systemic view that may include the relationships being generated with other projects; which are also being implemented in order to complement, and be complemented, by this special issue, in the context of the Program FIC.*

*This description of FIC will be oriented to WHAT FIC is, WHY FIC is important to be implemented and HOW we are trying to do it via Action-Learning, Action- Incremental-evolutive-Design, by means of initially smaller, then larger projects.*

*Keywords: Inter-Disciplinary Communication, Inter-Disciplinarity, Knowledge Integration, Systems Approach, Cybernetic Relationships,*

## **1. A Program for Fostering Inter-Disciplinary Communications**

The International Institute of Informatics and Systemics (IIS, [www.iis.org](http://www.iis.org)) is planning and implementing a program for Fostering Inter-Disciplinary Communication. The methodological planning is an incremental one (Braybrooke & Lindblom, 1970), in the context of an evolutionary process supported by Action-Learning and Action-Design. This is why the process is a systemic one, including systematic sub-processes. The IIS is providing (partially, at least) financial support for this program for Fostering *Inter-Disciplinary Communication*.

In the first phase of this program, the IIS has been providing, for at least 5 years to participants of the conferences, that it organize, the *option*<sup>1</sup> of making an additional presentation at the conference ***for inter-disciplinary communication, with no additional cost***. This presentation should be related to the content of the ***intra-disciplinary communication*** that they were scheduled to present, but oriented to non-disciplinary communication with non-disciplinary and non-technical terms, so it can be understood by conference participants from other disciplines. They were also invited to re-write their intra-disciplinary article FOR inter-disciplinary communication, which would also be published in the respective conference proceedings.

Those conferences' participants who take the above mentioned option, would also have the additional option to send an invited paper, written for ***inter-disciplinary communication*** and associated with the verbal presentation that was made at the conference, also *for inter-disciplinary communication*. These invited papers were included, as such, in the post-conference volume of proceedings, with no additional cost to their authors. A similar project is being implemented for the IIS's journal in which this special issue is inserted. In this way, the multi-disciplinary forum of these conferences would be supporting the potential inter-disciplinary communication which is one of the main purposes of the IIS<sup>2</sup>.

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<sup>1</sup> Italic and bold fonts are not being used for flashy effects or as emotional expression but to convey a message regarding the term or the phrase being used and its importance in the context in which it is used and/or a main purpose of the article. In other words, we are using italics and bold font to draw attention from the reader, not to convey any flashy effects or a subjective connotation.

<sup>2</sup> Some details regarding this purpose are briefly describe at the Current Main Purpose and Activities of the IIS <http://iis.org/purposeactivities.asp> and are posted at each Conference web site. See for example <http://iis.org/cfp-summer2021.asp>

This special issue is part of the initiation of a *second phase* with a similar purpose. The journal is a multi-disciplinary publication, where the best 25%-35% of the papers presented at the respective conferences, are published. The best papers are selected by the respective conference audience. The authors of these papers are provided with the possibility of extending their best paper up to 100% in order to reflect the feedback they may have gotten at the conference.

The authors of papers included in this special issue are authors of best papers, i.e. their papers went through three reviewing processes: the traditional double-blind, the reviews of non-anonymous reviewers, and the selection made by their peers at the conference because the respective audience is who select the best papers, not the organizers or the Program Committee. Each of these three reviews is a necessary condition but none, alone, is a sufficient one.

Periodically, a special publication will be made with the invited papers written for inter-disciplinary communication providing *links* to the respective paper that was written for *intra-disciplinary communication*. This would be one of the ways with which the IIS would relate *intra- and inter-disciplinary communications*<sup>3</sup>. This may have the potentiality of generating cybernetic loops and potential synergies for the writer and the readers. These special publications of invited papers *for inter-disciplinary communications* will have special promotion via academic/professional social media as, for example, Academia.edu (a community of about 100.000.000 academics and researchers). Any reader of any of these invited papers will also have a link to the peer-reviewed paper used for intra-disciplinary communication. This certainly might increase the readership of the paper and, hence, its potential impact.

Those participants whose regular (peer-reviewed) presentations were already made in an inter-disciplinary field and oriented to inter-disciplinary communication have the option of working on an invited paper, oriented to answering any of the following questions, regarding inter-disciplinary Research, Education, and/or Communication (IDREC, which is a special track in all the IIS conferences):

1. **Why** is IDREC important and necessary for the advancement of Science, real-life problems solution, and/or technological innovations?

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<sup>3</sup> More details regarding the potential synergies of relating intra-disciplinary and inter-disciplinary communication we included in Callaos, N. 2015 (especially in figure 1 and table 2) posted at (Callaos & Callaos, 2015).

2. **What** IDREC is, and/or might be: description of the related concepts supporting any of these three activities as well as the potential relationships and potential cybernetic loops among them.

3. **How** IDREC might be achieved? This issue may be addressed conceptually, via practice-based research and/or reflections, or presenting *case studies*; which level of effectiveness shows the potential of generating more similar practices and/or potentially more case studies on this issue.

*Additional phases* will be implemented in the future for fostering inter-disciplinary communication. The conception of the next phases will depend on the learning process generated by implementing these initial phases in the conferences, as well as in the journal,

## **2. Inter-Disciplinary Communication and Critical Thinking: A Main Purpose of this Special Issue**

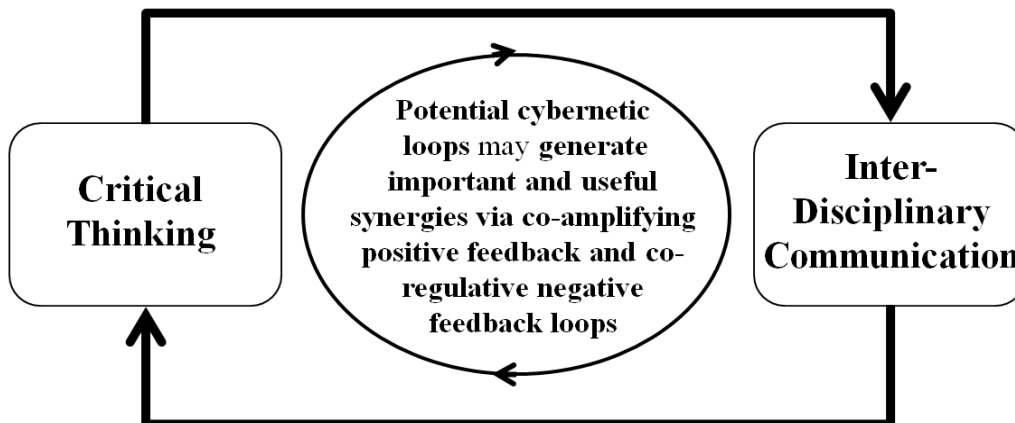
In the context of **Fostering Inter-Disciplinary Communication (FIC)**, the IIS started in its fall 2012 conference conversational sessions with regards to the intellectual, academic, and pragmatic benefits of inter-disciplinary communication. The benefits of Inter-Disciplinary Communication are also generated for *intra*-disciplinary research, education, and communication. One of these benefits is the improvement in *Critical Thinking* skills. With regards to this issue, in the IIS's Fall 2012 conference. We provided the following input to a Participatory Panel on the *Effectiveness of Critical Thinking for Inter-Disciplinary Communication and vice versa*, all of which was a main purpose of this special issue.

Critical Thinking<sup>4</sup> (CT) supports, and may be supported<sup>4</sup> by, effective processes of Inter-Disciplinary Communication. The potential cybernetic loops between these two kinds of cognitive processes might generate important and useful synergies by means of (co-amplifying) positive feedback and (co-regulative) negative feedback loops. Let us provide short preliminary reasoning with regards to the just ventured hypothesis or reflection; which we schematized in figure 1.

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<sup>4</sup> There are different definitions, notions, and conceptions of "Critical Thinking." We are mostly using here the notion consensually identified by 47 scholars and experts who went through 6 Delphi Method's rounds during 20 months. The result of this Delphi consensual procedure has been reported in the much known "The Delphi Report". An executive summary on this report can be found in (Facione, 1990) The Complete Version of the American Philosophical Association Delphi Research Report is available as ERIC Doc. No.: ED 315 423

CT transcends disciplines. It is a trans-disciplinary form of thinking and might provide an effective support for inter-disciplinary communication. CT provides what is common to different disciplinary or domain-specific cognitive/conative processes.



Mental activities needed for effective inter-disciplinary communication require cognitive and conative processes centered on Critical Thinking, especially on the skills related to an effective use of natural language and Informal Logic

**Figure 1:** Cybernetic and synergic, relationships between critical thinking and inter-disciplinary communication

The trans-disciplinary nature of Critical Thinking (CT) is among the consensual findings and conclusions achieved by 47 scholars and experts in Critical Thinking (CT). This was affirmed and described in the Delphi Report (Facione, 1990). It is affirmed, in this report, that "*while CT skills themselves transcend specific subjects or disciplines*, exercising them successfully in certain contexts demands domain-specific knowledge, some of which may concern specific methods and techniques used to make reasonable judgments in those specific contexts."<sup>5</sup> Consequently, it is affirmed, in recommendation 3, that "becoming adept at CT involves learning to use CT skills effectively in *many different contexts*."<sup>6</sup> Hence, it is evident that we can conclude that *different disciplines provide different contexts and, consequently, effective inter-disciplinary communication develops critical thinking, in general, as well as in the specific discipline of a researcher, scholar, educator, professional, etc.*

Since what is *common* to different disciplines is CT and what might differentiate them is the respective domain-specific knowledge (including specific semiotic systems, methods, concepts, definitions, theories, and techniques), it seems evident to conclude that CT is what may effectively communicate disciplinarians from different disciplines, i.e. *CT is a trans-disciplinary form of thinking and may provide effective support for inter-disciplinary communication*. Being *common* to different disciplines, CT might support *communication* among disciplines and/or among disciplinarians.

<sup>5</sup> (Facione, 1990, pág. 5) (Emphasis and italics added).

<sup>6</sup> (Facione, 1990, pág. 5). (Italics added).

Natural language semiotic systems are also *common* to different disciplines and hence may also support the inter-disciplinary *communication*. Hence, Critical Thinking and Natural Language Semiotic Systems (along with intellectual rigor, to be briefly described below) reinforce each other in supporting inter- and trans-disciplinary communication.

### 3. Intellectual Rigor

To have the kind of dual support mentioned in the above section (Critical Thinking and Natural Language Semiotic System) *requires more intellectual rigor* because more objectives should be achieved with potentially more restrictions. In (Callaos & Marlowe, Inter-Disciplinary Rigor, 2020) and in (Callaos N. , Intellectual Rigor in Information Systems Development, 2020), we concluded that *the level of rigor depends on the effectiveness in achieving objectives, while being restricted by principles* (e.g., axioms, natural laws, accepted theories, etc.) *and constraints* (e.g., disciplinary semiotic systems and methods, environmental limitations, etc.). Consequently, to fulfill the constraints related to different semiotic systems (e.g., disciplinary, natural language semiotic systems, different disciplinary semiotic systems, etc.) is intellectually more demanding and rigorous than to fulfill the restrictions of just one disciplinary semiotic system.

The intellectual effort required to translate between and among different semiotic systems generate a more comprehensive understanding of what is being translated. Any professor in Math trying to translate the mathematical semiotic systems into the natural language of her/his students knows very well the additional intellectual effort that should be made and the more rigorous is the educator thinking because she/he has to be restricted by both the mathematical and the natural language semiotic systems. Additionally she/he has to achieve two principal objectives: 1) to be understood by her/his students. In order to provide them with mathematical education, i.e. to be able to transfer mathematical knowledge and 2) achieve a mathematical truth. This is why a professor in mathematics, explicitly or implicitly, use mathematical analysis (truth discovery process) and synthesis (demonstration of the truth)

Similar situations happen in other educational contexts, as well as in inter-disciplinary communication where the communicants have the will to understand and to be understood. In these situations, explicitly or implicitly, educators use Critical Thinking (usually supported by analytical and synthetical thinking) to have effective communication, as well as analogical and metaphorical thinking. All of this requires more intellectual tools to get communicated. The benefit of this additional effort is the

development of the intellect and *a more comprehensive understanding of what is known*. The latter is due to the handling of more contexts, which may include different semiotic systems. *The more contexts, the more comprehensive is the understanding of what is already known*.

This is why Critical Thinking may also support non-disciplinary communication as, for example, the one required for communicating Science and Engineering to the general public, which is an important feature for legitimating scientific and engineering activities, especially those related to basic research.

This conclusion coincides with the academic and professional experience of many colleagues. In my personal<sup>7</sup> case, the development (analysis, design, implementation, and deployment) of more than 150 software-based information systems, in Academy and in our consulting firm, software engineers, consultant, project managers, etc. needed to be able to communicate with different disciplines as well as with the users, who mostly are non-disciplinarians (including workers and clerks who might not have had formal college education). Does this kind of communication require more or less rigor to be effective with the users, the managers and with the software engineers?

For example, information systems (supporting activities in Human Resources) require the identification, verification, and validation of requirements from professionals in psychology, accountancy, finance, economists, lawyers, managers, statisticians, unions, etc.; and their users include clerks, besides the kind of professionals just mentioned. Consequently, inter- and non-disciplinary communication is, each, a *necessary* condition, though not a sufficient one, in the effective development of information systems. Does this situation require more or less rigorous thinking or intellectual rigor?

Consequently, implicit or explicit, formal or informal education in Critical Thinking is an important issue in the education of information system engineers who need inter-, and non-disciplinary communication skills in order to provide computer professionals, software engineers, and programmers with information related to the respective system's requirements; which should be done in *disciplinary* language, and which will end up in the *Artificial Language* required as input to the computer. In this case, skills in translating between semiotics systems are required in, at least, among three semiotic systems: 1) natural languages, 2) software design language that depends on the methodology being used (e.g. the old flowcharts, the Structured Analysis and Design, etc.), and 3) one or more artificial languages.

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<sup>7</sup> The intention of referencing to "my personal case" is to separate the notion of knowledge and experiences. They are strongly (even cybenetically) related in practice but they still are very different notion. Experience includes implicit knowledge, intuitions, imaginations, Abductive Logic, Informal Ends-Means Logic, etc.)

All of this means that more intellectual rigor and more skills in critical thinking are required for effective development and maintenance of information systems.

### 3.1 Informal Logic and the Trivium

It also becomes evident that inter-, and non-disciplinary translation and communications skills, as well as effective use of *Natural Language* and Critical Thinking are required in information systems development. Correct, relevant, and adequate ***Informal Logic***<sup>8</sup>; which necessarily precedes the kind of ***Formal Logic*** required in Software Engineering, programming, and, in general, computing activities and processes. This kind of *chronological precedence* and *logical necessary condition* is also found in many professions, applied sciences, and new disciplines named with hyphenated words, which represent the integration of different disciplines. In this kind of circumstances, Critical Thinking, natural language skills, and effectiveness in handling informal logic in order to support the effectiveness of inter- and non-disciplinary communication with others and with oneself (self-communication supports our thinking processes).

Informal Logic is part of the Greek Logos, especially in the context of the Trivium: Ethos, Pathos, and Logos.

This is one of the several reasons why we have, on several occasions, pointed out at, and emphasized on, the ***importance and the effectiveness of triviality*** in the original sense of this word. Triviality has had, for a long time, a pejorative sense. It came to mean the quality of being trivial, i.e. ordinary and commonplace. But etymologically, “trivial” derives from the Latin word *trivialis*, and this derives from *trivium*. As we described elsewhere<sup>9</sup>, the word “trivium” was used in the “Middle Ages” to mean a group of three subjects, related to language teaching, which formed part of the curriculum. The other four subjects taught formed the group named the *quadrivium*. The *trivium* meant the “three ways” to language, to its good and effective use. These three ways or subjects are: Grammar, Dialectic (in the sense of Dialogic), and Rhetoric. *Grammar* teaches to speak well. *Dialogic* provides the art of maintaining a

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<sup>8</sup> We are using, here, the notion of “Informal Logic” with the same meaning provided by The Stanford Encyclopedia of Philosophy, i.e. “ thinking, reasoning, and argument as they occur in ***real life contexts***: in public discussion and debate; in education and intellectual exchange; in interpersonal relations; and in law, medicine and other professions. Informal logic is the attempt to build ***a logic suited to this purpose***. It combines the study of argument, evidence, proof and justification with an instrumental outlook which ***emphasizes its usefulness in the analysis of real life arguing***.” (Groarke, 2020) [Italics and emphasis added]

<sup>9</sup> (Callaos & Callaos, Toward a Systemic Notion of Information: Practical Consequences, 2002); (Callaos & Callaos, Toward a Systemic Notion of Information: Practical Consequences (Extended Version), 2011);



useful dialogue, i.e. competent communication. And *Rhetoric* provides the means of doing pragmatically effective use of the language, i.e. obtaining the practical results sought by the use of the language. So many people knew the *trivium* in the Middle Ages that its three integrative subjects become commonplace. Hence, the word *trivialis* emerged; which means “trivial.” And, here we have a *bewildering paradox*: what was a common place in the Middle Age education is not so common, in our time, especially in professional activities and inter-disciplinary communication, which need it the most. ***Trivium is not trivial anymore in our time***, especially in the field of information systems (and other professional activities), where it is so needed and almost a necessary condition for the effectiveness of these activities.

It is not being adequately taught; at least, in informing sciences and it is not at all included in Computer Engineering or computerized Information Systems Engineering curricula. Similar situations happen in other professional academic fields. *Trivium* is as essential to an Information Systems Engineer’s performance as it is to a lawyer. Until Information Systems (and other professional) curricula designers do not understand this situation, the importance of solving its related problem and the real necessity of including in the respective curricula a *trivium*, adapted to our times and to the Information Systems field, there will be no strong hope in increasing the future professional effectiveness of the students, to an adequate level regarding their professional activities efficacy.

### **3.2. Urgency of more Critical Thinking in Higher Education**

A lack of the most essential feature in Higher Education is happening in almost all majors in post-secondary 2-4 years colleges, in the USA. See the unexpected and unbelievable statistics presented in figure 2. Just 13% of college students are literacy proficient. Most importantly is that “With only a few exceptions, average literacy did not differ significantly across academic majors” (U.S. Department of Education, National Advisory Panel, 2006, pág. 52).

Inter-, Tran- and non-disciplinary communication may be solidly supported by an updated version of the Trivium: Grammar, Dialectic (in the sense of dialogic and argumenting skills), and Rhetoric (Ethos, Pathos, and Logos). To make the intellectual effort to be understood (via semiotic translation) and to understand a different disciplinary semiotic system, require Pathos, i.e. empathy and motivation, and who is motivating necessarily require Ethos in order to be sure about the ethical intentions of the motivator. In the context of inter-disciplinary communication, a minimum of “act of good faith” is required regarding who is transmitting information or knowledge from other disciplines, not well known by the listeners from other

disciplines. Consequently, Ethos is a necessary condition for effective inter-disciplinary communication. Similarly, an adequate Pathos is required from speaker to be the shoes of the listener and an adequate and shared Logos is a must.

Table 2.3. Percentage of U.S. adults in college and the nation in each document literacy level, by selected characteristics

Characteristic	Below Basic			Basic			Intermediate			Proficient		
	2-year	4-year	All adults	2-year	4-year	All adults	2-year	4-year	All adults	2-year	4-year	All adults
<b>GENDER</b>												
Female	1	1	11*	8	4	22	68	58	54*	24	38	13
Male	1	0	14	7	5	23	69	52	51	24	43	13

**Figure 2:** Source: 2003 National Survey of America's College Students and 2003 National Assessment of Adult Literacy (U.S. Department of Education, National Advisory Panel, 2006)

On the other hand, we would think that the *trivium* was the middle age way of teaching Critical Thinking. An adaptation of the *Trivium* to the XXI Century would be an adequate way to prepare disciplinary professionals to communicate with (non-disciplinary) users of their professions and, of course, to communicate with professionals from other disciplines. As we already mentioned, Critical Thinking is a necessary condition for communicating, via natural language and informal logic. Both are necessary conditions for communicating disciplinarians with non-disciplinarians as well as with disciplinarians from different disciplines. This is why the IIS has been trying to foster inter-disciplinary communication for more than 25 years and this is the reasoning supporting the IIS's programs and projects related to Fostering Inter-Disciplinary Communication (FIC). It is hoped and planned that this journal's special issue is the first of a series of similar publications, potentially with more understanding and acceptance from the authors of next similar issues. This would motivate them (Pathos) to make the additional intellectual effort to translate from their disciplinary semiotic systems to other semiotic systems.

Additionally, as noticed in Figure 1, the kind of thinking required for inter-disciplinary communication needs mental activities that would support additional development in Critical Thinking skills in those who are willing to exercise their cognitive and conative capacities in communication with disciplinarians from different disciplines. Facione (Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction, 1990, p.4) affirms that "Like reading and writing, Critical Thinking has applications in all areas of life and learning." Consequently, CT has application in all disciplines as well as in intra-, inter-, trans-, cross- and non-disciplinary thinking, learning, and communicating. As we wrote above, CT is associated with the **common** skills required in any kind of

thinking and, hence, provides skills for communicating, because to communicate requires to think and to have the support of commonalities.

The specific concepts, terms, theories, methods, terms, definitions, standards, etc. that characterize a given discipline might not support the communicational process with other disciplines, and certainly do not support a non-disciplinary communication. Consequently, *those who effectively engage in inter-, or non-disciplinary communication have to restrict their thinking to what is common with other disciplines (or to what is common to the general public) and this necessarily involves CT mental processes.* These active processes in CT, where disciplinary concepts, terms, theories, etc. may not be used for external expression of thoughts, activate the neural nets associated with critical thinking skills, which, as skills, the more they are used the more they get interiorized and solidified. The more restrictions we impose on our thinking regarding disciplinary concepts, terms, theories, definitions, etc., the more we need to use cognitive processes that are (or should be) **common** to other disciplinarians' (or non-disciplinarians') cognitive processes. This evidently, very probably, would improve the thinking/communicational skills which are not exercised via specific-domains. These non-specific-domain skills are, by definition or conception, the CT skills. *Consequently, inter-disciplinary communication would implicitly improve CT skills.*

In a conclusion, we may venture the hypothesis or reflection we made at the beginning of this section, i.e. ***Critical Thinking supports, and may be supported by, effective processes of Inter-Disciplinary Communication.*** If this is a valid reflection, or conclusion, then co-regulative and synergic co-amplifying cybernetic loops might be generated via negative and positive feedback, respectively (Figure 1). Consequently, an author trying to re-write her/his intra-disciplinary research and article for inter-, trans-, or non-disciplinary communication 1) develops the 'muscle' of her/his critical thinking, 2) develop her/his analogical thinking and facilitates creative analogical thinking in readers from other disciplines or other inter-disciplinary fields, and 3) help in relating the academic world to Industry, Business and the general public. The latter may 1) make more explicit and visible the social function of the academic world and, hence, may increase the level of perceived legitimacy of the Academic World and of Scientific Research and 2) increase the synergies between Society and Science/Technology.

Regretfully, Higher Education is frequently reduced to Higher Instruction; the latter is a necessary means for Higher Education but it should not be taken as an end in itself. We should avoid reducing Higher Education to mere instructions in a given discipline. Inter-disciplinary communication and increasing the level in critical

thinking is the least we can do in order to avoid falling in an intra-disciplinary that is, intentionally or unintentional, reduced de pass exams in the instructive dimension of Higher Education. What about Ethics? What about the skills and cultivating the habits of self-motivation and self-education? What about providing a more comprehensive Logos, not reduced to one or a few logics? What about including natural language proficiency in the notion of Logos, as it was included in Greece and the Middle Age?

#### **4. The Importance of Triviality in Intellectual Rigor**

In this section we will be referring to the two main senses of triviality, i.e. 1) in its sense of trying to be “*trivial*” in communicating no trivial content, in a way that may be understood in other disciplines and/or by the general public, and 2) in its sense related to the Trivium: Grammar, Dialectic (Dialogic), and Rhetoric (Ethos, Pathos, and Logos)

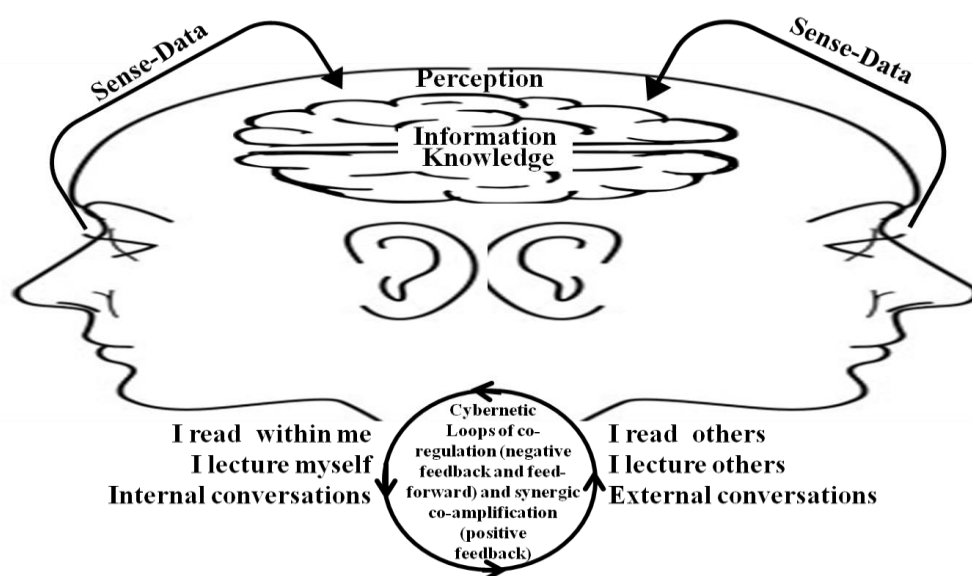
The purpose of this short section is to express in as few words as possible “The Importance of Triviality in Intellectual Rigor”, i.e. to be understood by scholars and students in other disciplines; which requires, as minimum, the same intellectual rigor needed to communicate with scholars in the same discipline. We found out, in our experience, that it is not easy to understand and to accept what we just affirmed because *many disciplinary scholars, researchers and educators confuse the notion of “intellectual rigor” with “precision”*. The latter is one kind of intellectual rigor, a means to achieve some kind of intellectual rigor, in some discipline(s), but in itself “precision” is not necessarily intellectual rigor. On the contrary it may go against intellectual rigor when the objective of the researcher, the academic, or the educator is to reach and get communicated with other disciplines, where the respective disciplinary semiotic system may have other ways of being precise, or may not be oriented to precision. Take the example of a medical doctor trying to communicate with a software engineer, or vice versa, regarding the requirements for a software the medical doctor needs to get a support for virtual interaction with her/his patient. This is just an example of the huge amount of ways of being precise. Add to that that in many other occasions, being precise jeopardizes communication with systems users; manager or the general public. In cases like these, being precise may be being anti-rigorous.

*Triviality seems not to be trivial anymore.* This might seem an oxymoron to educators and intellectuals, including scientists, engineers, philosophers, theologians, etc. Let us try to show why “triviality” is important, in its two main senses, i.e.

“trivial” 1) as related to the “trivium, or liberal arts”, “meeting of three roads” and 2) “cross-road, hence common, commonplace” (The Century Co., 1889/1911, p. 6493).

Elsewhere (Callaos, 2020), after an etymological and brief historical review on the different senses in the meaning of the term “intellect” and the different ways in which the respective concept has been defined, we made the conclusion that may briefly be represented by the visual metaphor of the two-faced Roman “God of Gods” Janus, who was “special patron of the beginnings and endings of all undertaking” (The Century Co., 1889/1911, p. 3218).

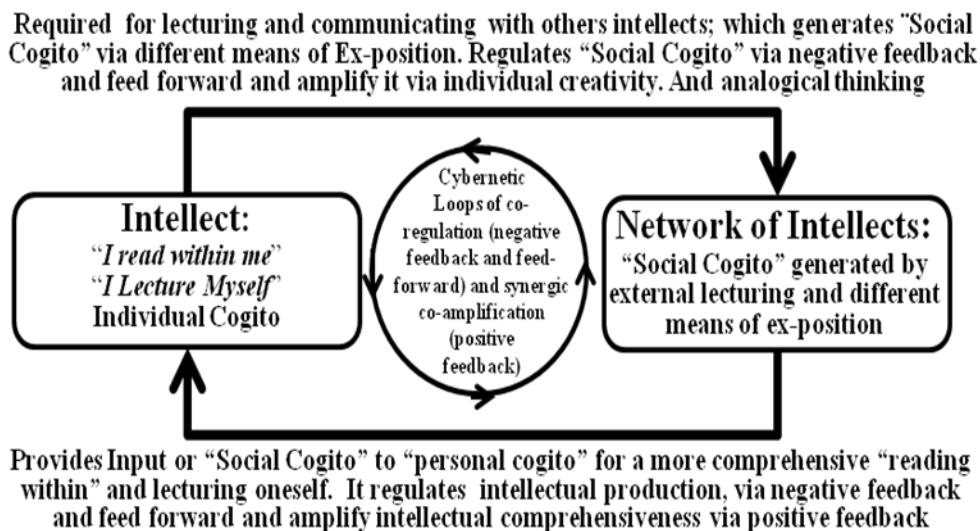
Figure 3 shows intellect as 1) “reading within”, “self-lecturing” (etymological meaning) and 2) as intellectual ex-posing, reading to others, teaching others. Into-lecture and Exo-lecture are cybernetically related with each other via co-regulative negative feedback (and feed-forward) and co-additive or co-amplificatory positive feedback that generate intellectual synergies and emergent properties (e.g., creativity, intuition, etc.)



**Figure 3:** Intellect metaphorically represented by the two-faced God Janus, the “special patron”, the beginnings and ending of all undertaking”. Intellect is reading with me and to other intellects. This generate a polar opposites, hence a cybernetic dialectic, generating co-regulative negative feedback (and feed-forward) and co-additive or co-amplificatory positive feedback that generate intellectual synergies and emergent properties (e.g., creativity, intuition, etc.)

This dual characteristic of the intellect: 1) “reading within”, “self-lecturing” and 2) as intellectual ex-posing, reading to others) ] generates not just co-regulative and synergic cybernetic loops, as the individual level but also at the social level (Sociological Cogito), structured by a network of individual intellect. Figure 4

synthesize in a diagram this aspect of individual intellect as related to other intellects. Consequently, it is essential for both: the individual intellect and the (intra-, inter- and trans-disciplinary networks of intellects (sociological cogito) an effective expression in order to have an effective communication with other individual intellects, which, in turn, is not just necessary for others but also to one-self. This is what the medieval Trivium is all about.



**Figure 4:** Individual intellects relates with each other, via different ex-position means, in a network on intellects, generating a Social Cogito, which feedbacks to its constitutive individual intellects generating cybernetic loops via co-regulative and co-amplificative feedback, which generate, in turn, synergies.

The trivium (Grammar, Dialectic (or dialogic), and Rhetoric) are needed by the intellect oriented to the quadrivium (arithmetic, geometry, astronomy, and music) though not necessarily vice versa. This is why the Trivium was taught before the Quadrivium. We may suggest that the actual equivalents to the Quadrivium are the different intellectual disciplines. All of them require an adequate skill of expression in order to have an effective communication even inside the same discipline, let alone with other disciplines or with the users of any of these disciplines. Science users should necessarily be taken into account in communicating the results of Science. This is the importance of a contemporaneous Trivium, based on the equivalent of Grammar, Logic, and Rhetoric. Grammar may be generalized to the notion of Semiotic Systems and the skills to translate, at least between disciplinary semiotic systems and Natural Language based semiotic systems. In this context, the Trivium Grammar should be the syntactic level of a semiotic system. Logic should be the most adequate one for the objective of effective communication. Consequently, it should be a shared logic like, for example, Predicate Logic.

Rhetoric (Ethos, Pathos, and Logos) is essential and completely necessary for any kind of communication including disciplinary communication and, in general, scientific communication and, more comprehensively, intellectual communication, which includes (but not limited to) Engineering, Technological, cultural, inter-cultural, inter- trans- and non-disciplinary communication. No matter what kind of intellectual production, rhetoric is needed and necessarily required for any kind of oral and written communication. Being this the case, how many scientists, engineers, etc., had been prepared in rhetoric? I am afraid that the number is not a large one. Why this is not included in Higher Education?

I personally<sup>10</sup> learned it the hard way when trying to design a methodology for Information System Development, then managing projects of information systems development during for 40 years.

## **5. Project in Trans-disciplinarity for Interdisciplinary Communication (TIC)**

This another project related to the program of Fostering Inter-Disciplinary Communication (FIC), in which this Special Issue is inserted, as a first step, in another related project, all of which oriented to the same general purpose of fostering inter-disciplinary communication, but with different ways and objectives

### **5.1 Objective of TIC**

The main objective of the “Project in Trans-disciplinarity for Interdisciplinary Communication” (TIC), which implementation had already started with several trans-disciplinary topics, is *fostering systemic-cybernetics relationships* between Trans- and for Inter-disciplinary Communication. Several special issues on trans-disciplinary topics of the journal are in the publication process via Participative Peer-to-Peer Reviewing (PPPR) in order to relate authors and generate written inter-disciplinary communication. It is also planned, for the next future, to complement this written communication with inter-disciplinary verbal communication, potentially via conversational face-to-face sessions and/or virtual meetings.

With a similar objective, special tracks on trans-disciplinary notions, concepts, or topics are being organized at different conferences of the IIS. This provides the reader of this article and special issue with a larger context and with a systemic

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<sup>10</sup> Once again I am using the personal fist pronoun to distinguish between knowledge and experience, which are strongly related but should be differentiated,

insertion of this special issue into a larger program of several projects oriented to foster the so needed (in our opinion) inter-disciplinary communication.

Trans-disciplinary topics, notions, and concepts are usually effective in relating authors, researchers, academics, and professionals from different disciplines. Consequently, Trans-disciplinarity is among the important means for interdisciplinary communication; which is a necessary condition for interdisciplinary research, education, and real-life problem-solving. This, in turn, is required for relating academic activities, knowledge integration, as well as for synergistically relating academy with industry, business, and Society at large. Furthermore, the opposite is also important, i.e.; Interdisciplinary Communication is also a means for creating trans-disciplinary topics, concepts, and notions. Consequently, cybernetics loops may emerge in relating trans-disciplinarity and inter-disciplinary communication.

This reciprocal and systemic-cybernetic relationship between Transdisciplinarity and Interdisciplinary Communication is not just a synergistic source, but also a means for creative analogical thinking which may be input to logical thinking, which would validate or invalidate what is produced by the created analogies among disciplines and between them and trans-disciplinary notions, concepts, and topics. This generation of analogies is important in scientific, engineering, technological and artistic creativity. Consequently, relating Transdisciplinarity with Interdisciplinary Communication, via systemic-cybernetic relationships, may also provide a substratum for potential integration of diverse intellectual productions and, consequently, close the gaps between the different intellectual cultures. Figure 5 provides a schematic summary of what we briefly described in this section.

## 5.2. Initial Phases

Initially, TIC will have the following two phases, which implementation would provide the experience and the learning process required for conceiving, designing, and implementing the next phases.

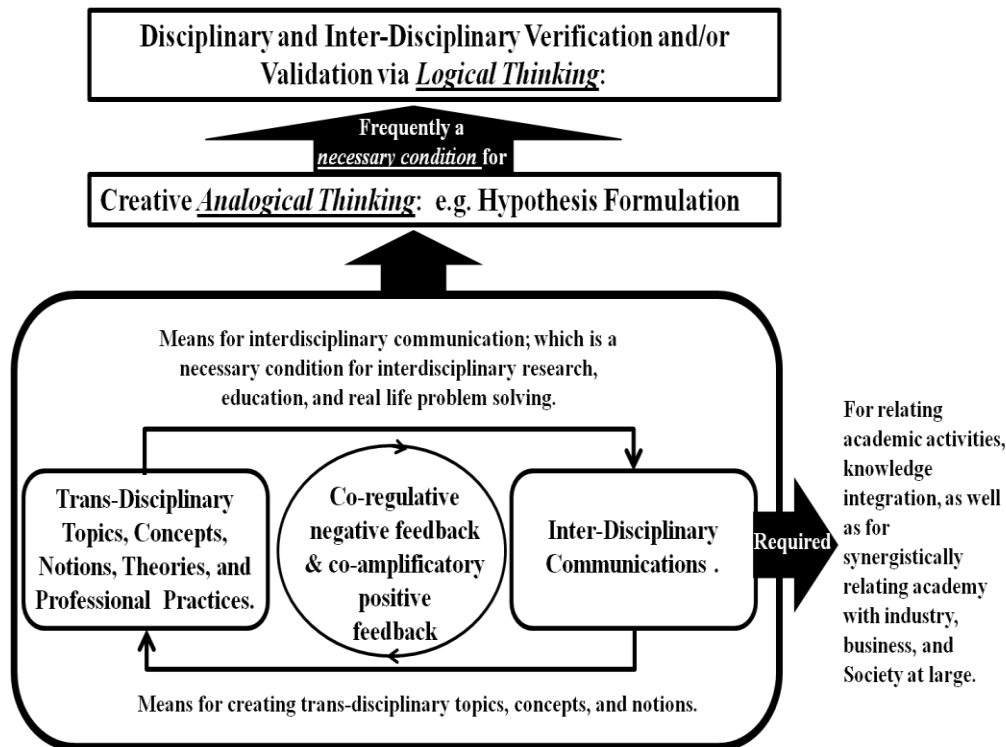
The goal of the 1<sup>st</sup> phase is to produce a special issue of the Journal of Systemics, Cybernetics, and Informatics (JSCI)<sup>11</sup>. The copyright transfer for this special issue will be, as usual, for open access publication, as it is the case of the journal, i.e. it would not include the writer right because this is a *human right*.

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<sup>11</sup> Notions, concepts, and theories in Systemics and Cybernetics provide the required substratum of trans-disciplinarity. Cybernetic tools (communication and control) and informatics technologies are being used in many disciplines, hence, they are disciplinary and inter-disciplinary tools and technologies, which application to real life problem require relating with other disciplines.



In the 2<sup>nd</sup> phase, a multiple author book would be published if the authors of the special issue are willing to adapt and extend their respective papers in different chapters of the book. The kind of copyright transfer for the book would depend on the publisher policy regarding this issue. If the IIS publishes the books, they will be distributed via Amazon. It will be via open books, especially because the electronic copy would be the special issue published in a free open access journal.



**Figure 5:** Trans-disciplinarity relates cybernetically with interdisciplinary communication, via negative and positive feedback, hence co-regulating each other as well as reinforcing each. All of these provide generate a synergies, which include the generation of 1) creative analogical thinking that would be input to logical thinking in order to be verified and 2) increasing the effectiveness of inter-disciplinary thinking in solving real life problems and, hence, relating synergically Academy and Industry/Business/Society

## 6. Inter-Disciplinarity and Disciplinarity: A Necessary Dialectics

An exponentially increasing number of articles are being written on Interdisciplinarity<sup>12</sup> and related concepts represented by adjectives such as

<sup>12</sup> About already thirty years ago, July Thompson Klein (Interdisciplinarity: History, Theory & Practice, 1990) published one of the most comprehensive and referenced books, as well as the one with the largest number of references and bibliographies on Interdisciplinarity and related topics. Almost 40% of the book is dedicated to references, and references and bibliographies. This makes the book, in our opinion, an intellectual jewel in the field, especially because its comprehensiveness as well as its *internal and external relatedness*, hence its

multidisciplinary, pluri-disciplinary, cross-disciplinary, trans-disciplinary, etc. We identified fewer publications on 1) the cybernetic relationships between “Inter-Disciplinarity and Disciplinarity”, 2) the synergistic dialectics<sup>13</sup> between both of them, and 3) the importance, even, the necessity, of these relationships in order to avoid potential a) *disciplinary inbreeding* and b) drawbacks of *intra-disciplinary incest* and, consequently, *Academic Incest*.

The strong term “Academic Incest”, with its very negative connotations, has been used in Academia to refer to hiring future professors who just received their degree from the same hiring university. Working in the same university, immediately after receiving the degree, is considered Academic Incest, which is strongly avoided by reputable universities. In some academic circles, receiving all degrees from the same university is also considered as academic incest and this is probably why some prefer to receive their different degrees from different departments, if it is not feasible for the student to move to other universities. It is, probably, also the reason for a mandatory minor, besides the major, in academic careers.

We will explore, in this section, other ways of Academic Incest with potentially even more hindrances, disadvantages and, potentially more unexpected crippling consequences.

Our methodological approach is based on 1) Reflexive Research (which adds to the objective reflections, subjective ‘Reflexions’<sup>14</sup>, and 2) relating “knowledge and experience”, “explicit and implicit” knowledge, and “theory and practice”. This will be attempted by means of a combination of different approaches and intellectual perspectives, like the following: 1) *Becoming a reflexive researcher: Using Ourselves in Research* (Etherington, 2004), 2) *The Reflective Practitioner* (Schön, 1983), 3) *Reflexive Methodology* (Alvesson & Sköldbberg, 2000), etc.

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systemness and systemicity. Based on this huge variety Klein suggests that there is no one definition of inter-disciplinarity but many. This is why interdisciplinarity is not a concept that may be defined but a notion that may be described by identifying 1) the most important of its definitions and 2) the actual or the potential relationships among them. We will be providing, in this article, more details on this issue.

<sup>13</sup> The word “dialectics” is being used here in its etymological meaning (from the Greek: διαλεκτική, dialektiké; related to dialogue); i.e. a process (dialectic method) oriented to a shared discourse between two or more intellectual perspectives in order to structure a “dialectic whole” that transcend its components via synergies and emergent properties.

<sup>14</sup> We are using the term “reflexion” as a process and product of “reflection plus self-reflection.” O’Leary (2004), for example, in *The Essential Guide to Doing Research* affirms that “Reflexivity in research refers to the ability of the researcher to stand outside the research process and critically reflect on that process. Research, as a ‘reflexive’ thinking process, “involves constant consideration of the researcher, the researched, and the integrity of the process.” (p. 11) Reflexive Research is to reflect on the received data and to make a reflexion on these data as well as *self-reflexion*, i.e. to observe both the object observed and the observer. This is a fundamental concept, is a required notion, and a necessary act in the **Second-Order Cybernetics**, which, in turn, is based on the Copenhagen Interpretation of Quantum Theory.

## 6.1. Comprehensive Overview

In this section we will try to convey a macroscopic and comprehensive perspective of 1) the relationships between disciplinarity and interdisciplinarity with which a systemic whole or, more specifically, a dialectical whole<sup>15</sup>, is generated with potential emergent properties (figure 6 and 7) the relationships of this systemic/dialectical whole with its environment, i.e. its supra-system which; as such, provides meaning, understanding, and legitimacy to both disciplinary and interdisciplinary research and education (figure 7). Then, in the following sections, we will provide some details related to the main purposes of this section, in the context of the purpose of this article. Some of these details will be a) fostering Analogical Thinking (input to logical thinking) and b) inhibiting the unintentional generation of unconscious academic incest; which might have a negative impact on disciplinary research and education, as well as on the Society at Large.

There are several scientific, pragmatic, and ethical reasons that justify the perspective of avoiding Academic Incest (More details regarding this issue will be provided in a following section). This is why the main purpose of this article is to discuss and show how most of these reasons also apply for the desirability, if not the necessity (which is our opinion), in decreasing the probability of *Intra-Disciplinary Incest* and, hence, *Academic Incest*. These are among the meta-objectives of this Special Issue.

This can be achieved by relating interdisciplinarity and disciplinarity

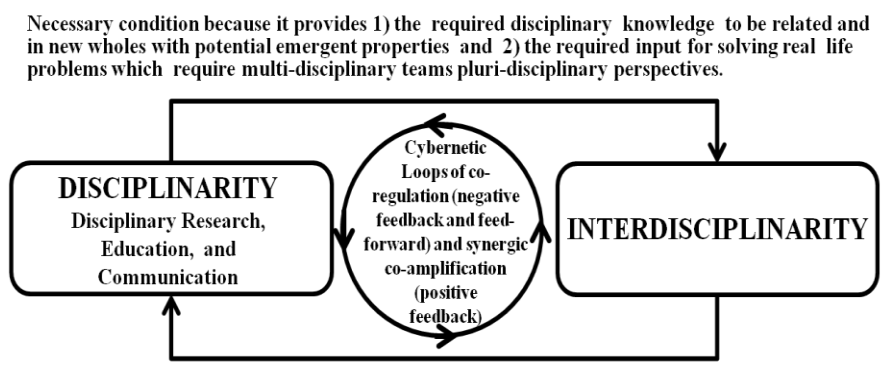
- 1) *systemically*, into a *whole* (a dialectic whole which might have beneficial emergent properties (e.g., analogical thinking, more creativity, etc.) and
- 2) *cybernetically*, via 2a) explicit co-regulative loops (negative feedback and feed-forward) and 2b) synergistic co-amplificatory loops (positive feedback).

Figure 6, briefly and schematically, describes the starting point of this section. Figure 7 shows the cybernetic environmental relationships of what is represented by figure 6; i.e. the *cybernetic context* (cybernetic supra-system) where the cybernetic system, shown in figure 6, as one of its sub-systems. The actual and/or potential cybernetic relationships, shown in figure 7, transform disciplinary and interdisciplinary research and education into two subsystems of a larger one; which, as a whole (a dialectic whole), might have emergent properties that cannot be found in its two sub-systems. These emergent properties might be *fostered or inhibited*. In our opinion, frequently

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<sup>15</sup> We are using the phrase “dialectical whole” in two of its senses which will be briefly described immediately below.

found academic promotional policies, procedures, and rules inhibit these relationships and, hence, dampen and curb the potentiality of the whole that is required for adequate *integration of the Academic System*<sup>16</sup> as related to the Society at Large. Having policies for academic evaluation and promotion centered in intra-disciplinary research (excluding the value of inter-disciplinary academic activities) might degrade the legitimacy of the Academic System; which, in turn, may reduce the resources provided by the Society at Large; which are as necessary (though not sufficient) conditions for its sustainability. Consequently, it is not just an ethical but also a pragmatic requirement to integrate the intra-disciplinary sub-systems (totality of disciplines) in the context of the whole systems shown in figure 6. In this way, this integrated System (dialectical whole) would be more adequately integrated to the Society at Large (supra-system figure 7).



Provides , (1) Analogical Thinking as input to Logical Thinking , (2) context for a more correct and adequate meaning and understanding of disciplinary knowledge, (3) macroscopic perspective to complement and orient the microscopic analytical parts, and (4) necessary condition in Ashby's Requisite Variety Law required for adaptability and hence for adequate evolution according the changing environment.

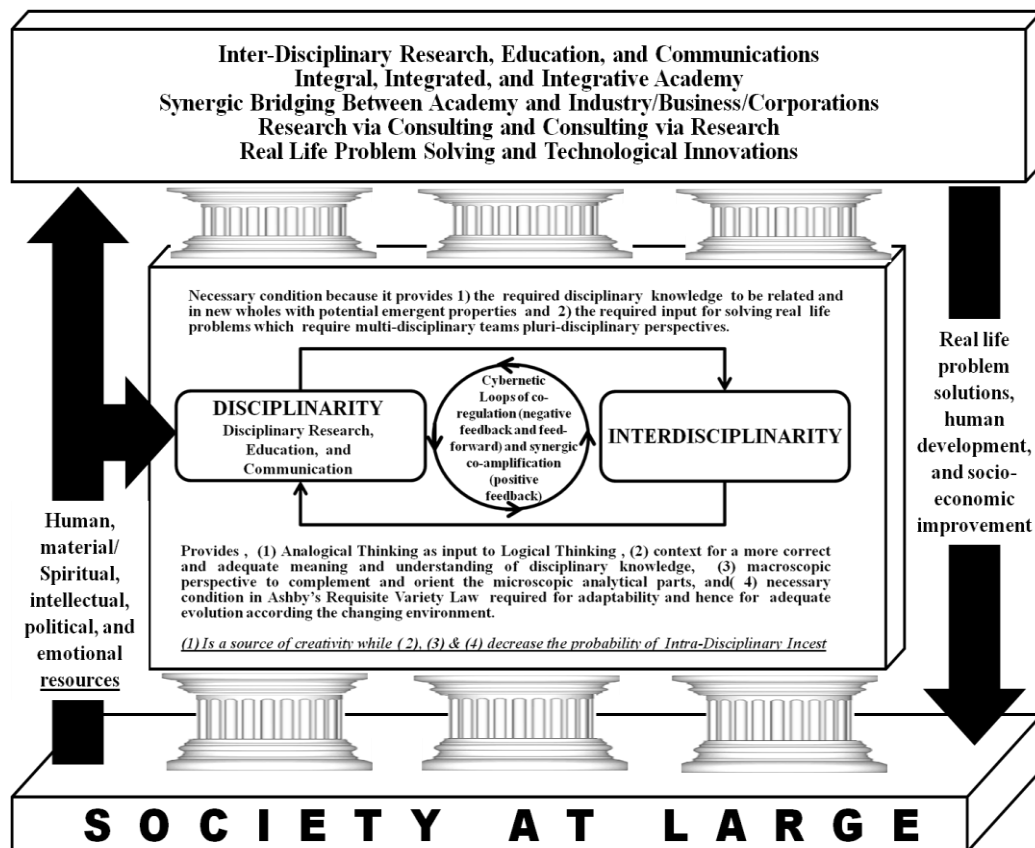
(1) Is a source of creativity while (2), (3) & (4) decrease the probability of Intra-Disciplinary Incest

Figure 6: Cybernetic relationships disciplinarity and interdisciplinarity where they, as polar opposites, includes and requires each other in the context of a dynamic dialectic that is a source of creativity, via analogical thinking, and an inhibitory of Intra-Disciplinary and, hence, Academic Incest. Figure 8 represents a zoom-out of this figure.

Some, probably many, readers might think that all of what has been schematically presented in this section is a set of truisms and platitudes. We do think that it is common sense, but we also notice that it is not being adequately applied in many universities in order to foster a higher degree of relating disciplinary to interdisciplinary research and education, which is required for more synergistic knowledge integration, in the context of Society at Large. On the contrary, it is easy to notice frequent policies, procedures, and rules (in academic promotional systems) that

<sup>16</sup> We will provide, in an ensuing section, more details about the importance of programs, plans and procedures oriented toward and Integral, Integrated, and Integrative Academy.

inhibit a more adequate integration of disciplinary activities into a larger whole, via interdisciplinary activities (research, education, and communication).<sup>17</sup>



**Figure 7:** The dialectic whole Disciplinarity/interdisciplinarity have implicit and/or explicit cybernetic relationships with Society at large via providing solutions to real life problems (which always are of multi- or inter-disciplinary nature) while Society at Large provides the human, material, intellectual, spiritual, and emotional means to the dialectic whole of Disciplinarity/interdisciplinarity

In the case of developed countries, this lack of integration is ameliorated by the industrial/ business/corporate environment. Extra-academic research, training, implicit education, and interdisciplinary communication (when facing real life problems; which, mostly, are of a multi-disciplinary nature) end up integrating, more adequately, academic processes and products to Society at Large. But, in developing countries 1) the lack of an adequate industrial/business/corporate infrastructure and 2) the strong tendency to copy, from developing countries, research and educational models represents a huge inhibitor and a hindrance to their development process. This is why what is *desirable* in developing countries, regarding the content of this article, is *important and urgent* for developing countries.

<sup>17</sup> We will provide, in a following section, more details about the importance of programs, plans and procedures oriented to integrate research, education and real life problem solving.

Regretfully, many academics in developing countries seem to have a *self-imposed* or *self-induced* (what we may call) “*intellectual colonialism*”. It is our opinion<sup>18</sup> that the phenomena are mostly unconscious, but sometimes, it is a negligent, reckless, indifferent, and even irresponsible attitude. Consequently, in our opinion, this attitude might be unethical and, potentially, on the frontier of academic misconduct. This is mostly generated by academic authorities because of not knowing the real meaning of the notion of education which might cause academic misconceptions. It also might be produced by the intellectual laziness that frequently is the cause of copying educational models, from more developed countries, without making any attempt to, at least, adequate them to the socioeconomic and academic circumstances of the respective developing country,

## 6.2. Intra-Disciplinary Inbreeding

Let us start this section with some perspective of other authors with regards to this issue. This would provide context for what we summarized at the beginning of this section, as well as in the reasoning, reflections, 'reflexions'<sup>19</sup>, that followed, and in the questions to be made below in order to generate potential reflections in order to answer them.

At the general level of the social sciences, Hofstede (1994) affirms in a frequently quoted preface that “Academic inbreeding and atomization in the West have led to extensive production of irrelevant speculations. *The system has become self-destructive in that it punishes rather than encourages borrowing from related disciplines*. Cross-cultural social sciences, therefore, cannot be, but cross-disciplinary”. (p. ix). [Italics and emphasis added]. Doesn't that apply to many academic disciplines, as well; especially when they are related to real-life problems that are usually immersed in social contexts? Doesn't that also apply to the natural sciences as such? We will provide some details below regarding this issue.

Meanwhile, let us note that there is an increasing number of authors affirming that Social Psychology, Cognitive Psychology, Sociology, Anthropology, Social Psychology provide empirical studies and theories that are important and should be applied in the design of Computer-Human Interaction (CHI) and in Computer-Supported Cooperative Work (CSCW). But, as Robert, R. Kraut (2002) affirms, that researchers and developers in these fields

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<sup>18</sup> Knowledge and opinion, i.e. Episteme and Doxa, are necessarily related. There is no Episteme not implicitly based on Doxa and no Doxa not based in some kind of knowledge, be it implicit or explicit knowledge.

<sup>19</sup> See footnote 14 above for a very short differentiation made between “reflections” and “reflexions”

“have rarely taken advantage of this trove of empirical phenomena and theory. There are several reasons why this body of research has been under-exploited. First are the *standard problems of disciplinary inbreeding*. In CSCW, as in many fields, researchers tend to know about and, therefore refer primarily to research reports, published in the restricted set of journals which they consider core to the discipline... articles published in CHI or CSCW proceedings and rarely refer to the reference literature in cognitive psychology, sociology, anthropology, or social psychology” [Italics and emphasis added]

Information Systems Engineering is another important area suffering from intra-disciplinary inbreeding and lack of interdisciplinary research, education, and communication. Computer Science departments frequently provide this education in many universities. Consequently, the respective curriculum is unconsciously and unintentionally biased toward computing (programming, Databases, etc.) instead of Informatics and Science instead of Engineering, which requires different preparation, even in logic. Programming, binary, predicates, etc. logics should be complemented with the *means-end logic* or, at least, the experiences oriented to develop the skills for means-end thinking, Confusing the means with the end (i.e., making the means as ends in themselves) is a “special case of incoherence” (Váry & Vecsenyi, 1983).

**6.2.1. Differentiating Among the Why, the What, and the How:** To avoid confusing the end with the means, that may produce the incoherence mentioned above, Kenneth Arrow affirms that he, as a consultant, asks at least two times why, when a client asks him for something. This is because Ackoff affirms, frequently, what the client identifies *what* her/his problem is, it is actually *how* s/he would solve it, not necessarily what s/he really wants, let alone, *why* it is wanted. This is why professionals like information systems engineers should ask the user at least twice: *why* the user/client is asking for what she/he is asked for. In Engineering and, in general, in any design activity *why, what, and how* should be well and explicitly differentiated in order to adequately relate them via cybernetic loops of co-regulation (via negative feedback and feed-forward) and co-amplification (via positive feedback).

Figure 8<sup>20</sup> provides a schematic summary of the relationships that end and means should have. The *thinking* process should go from the end (the why) to its means (the

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<sup>20</sup> In figure 7, we are using the term etiology in its general sense of “a branch of knowledge concerned with the causes” (Merriam-Webster, 1999, p. 399). We will be using it in the context of Science, mainly inductive, or more precisely, empirical science. We will not use it with the restricted meaning used in Medicine, nor out of scientific domain as in mythology. This meaning derived from the etymology of the term: the Greek *aitaia*: “cause”. We are using it in the sense that is usually used in physics, philosophy, medicine, psychology, government, biology, etc.; in order refer to the causes of effects or the origins of different phenomena.

goals) and from the goals to the how. The *action* should proceed from the means to the end, i.e. from the “how” to the “what” and from the “what” to the “why”. Design-centered professionals (e.g., engineers) relate thinking and action with, implicit or explicit, reciprocal, or potentially cybernetic, relationships. A combination of Action-Research, Actions-Design, and Action-Learning is usually (implicitly or explicitly) used.

Are the respective students being prepared for such a kind of process when their education is centered just on, or mostly on, Science courses? These courses are *necessary* conditions for Engineering (and other design-centered careers) but, are they *sufficient*? Actually, science is an *end* in the education of scientists, but it's just one of the *means* in engineering education. Are means being confused with ends in engineering education? If so, Intra-disciplinary inbreeding might have more devastating effects in design-centered professions or in the preparation of students to solve real-life problems. This is because in real-life problems and related designs frequently, if not always, require the concurrence of, and the coordination among, multi-disciplinary teams, hence skills in interdisciplinary thinking and communication are almost a must. In these situations, the undesirable effects of *intra*-disciplinary inbreeding are amplified because of the multi-disciplinary nature of real-life problems and design-centered activities. Are we providing the students of Engineering and other design-centered and real-life problem-oriented careers with the required intellectual preparation?

### **6.2.2. Pragmatic and Intellectual Consequences of Confusing Ends with Means**

To unconsciously confuse ends with their means is one of the consequences of intra-disciplinary inbreeding. The knowledge learned in a discipline is a means not an end in itself, especially in professional careers, though it is also an implicit or explicit mean in scientific activities. The negative effects of intra-disciplinary may have disastrous results in both and in scientific activities or interpretation, as we will see in some examples below, and a waste of time and resources in professional activities besides the risk of dangerous wrong decisions, based just on an intra-disciplinary perceptions and conceptions..

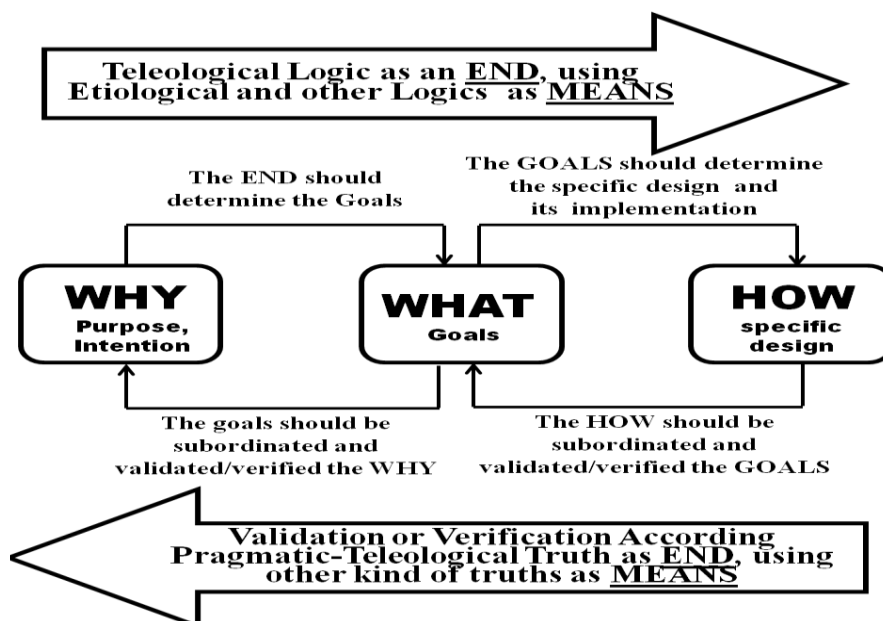
In other words, to confuse means with their end might be disastrous at the pragmatic level, in general, and not just in the case of design centered professional and Research and Development activities. Let us note two famous quotes regarding this issue; one is made by a much known physicist and another by a reputable and well-known humanist (moral and social philosopher)



“Perfection of means and confusion of goals seems, in my opinion, to characterize our age.” Albert Einstein, (Out of My Later Years, 1950). Ch. 34.

“Given the means, we hang on to them and often forget the ends.” Eric Hoffer (Reflections on the Human Condition, 2006)

To confuse the end with the means may be the cause and/or effect of disciplinary inbreeding. Engineering, for example, requires adequate preparation not just for in Etiological (causality and determinism) Logic but also in Teleological (intentional, means-end) logic. In disciplines like Engineering, Architecture, etc., i.e. design-centered disciplines (mentioned above) there should be an *explicit differentiation* between the "How", the "What", and the "Why", as shown in Figure 8. Is that being done in Higher Education? As long as this differentiation is not done and the curricula are decided by scientists and the courses are provided by scientists, then there would be confusion between the “why”, the “what” and the “how”. It may be even worse, if Etiology is taken as an end in itself and not as means, in the context of teleological thinking. This would certainly worsen the effect of intra-disciplinary inbreeding. etiological thinking is an end for scientists, but it is one of the important (and potentially necessary) means for R&D activities, design-centered professions, policy/decision-makers, including those in universities (as academic promotion committees, department chairs, deans, boards, etc.), research centers, grants organizations, publishers, peer reviewers, etc.



**Figure 8:** Thinking/Action processes for designed centered Research and Development, where Etiological and other scientific logics are not an ends in themselves (as it is the case of scientific activities) but MEANS used for achieving the teleological logic. Similarly scientific truths are means used in thinking/action processes oriented to the pragmatic-teleological Truth, required in design-centered activities.

There is more implicit disseminated disciplinary inbreeding than what one can imagine. One way to avoid that, or to diminish its dissemination, might be by means of emphasizing inter-disciplinary research, education, thinking, and communication. This would develop critical thinking and, hence, differentiate between the different kinds of logic and, hence, the use of the more adequate thinking for the design (*'designium'*, intention, objective)

This would increase the potential synergies that may be generated by the cybernetics loops shown in figures 6 and 8; which, in turn, would certainly increase the integration of the academic world to Society at large and, hence, its social, economic, and ethical legitimating (Figure 8)

**6.2.3. Examples of Intra-Disciplinary Inbreeding:** Let us now present other examples in other disciplines. In the specific case of Economics, Michael Bernstein (The American Economic Policy Environment of the 1990s: origins consequences and legacies, 2006) affirms that “It has been long the conviction of those who study the history of the sciences that moribund intellectual traditions may be overcome only by the effective articulation of alternatives” (p. 266). Then he argues, in the same paragraph, that “disciplinary inbreeding [in Economics] was hardly conducive to alternative paradigms. (p. 266).

In Political Science, a good example is the vitriolic Humphries/Miyoshi controversy<sup>21</sup>, which is presented by William H. Thornton (2002) as a result of “disciplinary inbreeding”. He affirms that “In its peevish excesses, the Humphries/Miyoshi exchange testifies to what comes from years of disciplinary inbreeding. Japanese culture is too integral to Japanese politics, and the latter is too crucial to the balance of power in Asia, to be left to academic Japonologists alone. What is sorely needed is more, not less, *interdisciplinary intrusion.*” (p. 64) [Italics added]. It should be noticed that, in our opinion, the combination, in this case of disciplinary and national cultures amplified the problem.

In the area of Behavior, including psychology and Biology, it is among those in which we can find of the more understandable examples of “*intellectual monstrosities*” that intra-disciplinary inbreeding may generate. These examples are most visible and, in our opinion, are explicit examples of what implicitly might be generated, or are already being generated, in several, if not in many, disciplines. In the following paragraphs of this section, we will use the highly recommended and referenced New

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<sup>21</sup> This was a very heated controversy. An example can be found in the way how Miyoshi accuses Humphries/ of being “malicious, ignorant, inaccurate, irresponsible, dishonest, fraudulent, lazy, sloppy, unhistorical, and incompetent.” Cited by (Thornton, 2002, p. 63)

York Times bestseller book of Robert M. Sapolsky (*Behave: The Biology of Humans at our Best and our Worst*, 2017)

Let us start with the first example that Sapolsky presents from well-known scientists.

“Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I’ll guarantee to take anyone at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant-chief and yes, even beggar-man, regardless of his talents, penchants, tendencies, vocations, and race of his ancestors.” (Watson, 1930). Quoted by (Sapolsky, 2017, p. 8)

The author of the above quote was ranked by *A Review of General Psychology* survey as the 17<sup>th</sup> most cited psychologists of the 20<sup>th</sup> century (Haggbloom, et al., 2002). Yes, we are referring to Columbia University’s professor John B. Watson, who established the psychological school of behaviorism and was also the Editor of the prestigious *Psychological Review*. *He wrote this quote in his well-known book (Behaviorism, 1930)*<sup>22</sup>. In our opinion, this is an example of the many problems with “isms”. They are a fertile intellectual platform for the generation of disciplinary inbreeding which potentiates intellectual monstrosities like the one we just mentioned above.

This is why, in another not published yet work, we suggested that we will try to avoid any kind of “-ism” in order to allow plural perspectives in the context of perspectival epistemology. Paraphrasing B. H. Kelly<sup>23</sup> (1988) we might probably say “no-ism, but pluralism” or “no-ism, but perspectivism”, but we prefer not to use the “-ism”, not even in this way. We will use the terms ‘plural’, “plurality of perspectives”, etc. When we use the postfix “-ism”, we would be referring to an intellectual movement or conception known with this postfix.” We think that following this suggestion while thinking and writing would, probably, lower the probability of falling into the “ism” trap and, hence, fertilizing the intellectual terrain for possible intra-disciplinary (or intra-intellectual-movement) inbreeding.

According to Sapolsky (2017) “Watson was pathologically caught inside a bucket having to do with the environmental influence on development”. He was inside the sub-sub-discipline he created in the context of the sub-discipline of experimental psychology in which knowledge inferred from experiments with animals were transferred to the knowledge domain of the discipline of human beings psychology. This kind of *peripheral intellectual blindness* might be dangerous because of the sub-sub-disciplinary incest it might create. “Acute bilateral blindness is an emergent

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<sup>22</sup> Referenced by (Sapolsky, 2017, p. 721) and cited by the same author (2017, p. 8)

<sup>23</sup> Referenced in Samuel Claude Shepherd (2001)

condition that may signal life-threatening disease” (Hoovel & Stack, 1996). Metaphorically, Intellectual peripheral blindness may be a life-threatening disease to the intellect with contagious consequences to other academics in the same discipline and, which is worst, to the students of the respective professor or lecturer. *Interdisciplinary research, education, and communication might be a vaccine against this intellectual disease, which is a product of intra-disciplinary inbreeding.*

Let us now present the second example provided by Robert M. Saposlky (2017, p. 9):

“Normal psychic life depends upon the good functioning of brain synapses, and mental disorders appear as a result of synaptic derangements ... It is necessary to alter these synaptic adjustments and change the paths chosen by the impulses in their constant passage as to modify the corresponding ideas and force thought into different channels.” (Egas Moniz, awarded the Nobel Prize in 1949). Quoted by (Saposlky, 2017, p. 9):

Is it *necessary* to alter these synaptic adjustments? Really? Does that make any cognitive or ethical sense? Should we reduce psychiatry, psychology, cognition, etc. to neurology or, worst, to neurosurgery? Does this make any sense to any intellectual? It seems that it made complete sense to Nobel Laureate Edgar Moniz, who, according to Zbigniew Kotowicz (2005), coined the term “Psycho-Surgery”. This neologism, that he created, may even be considered a ‘*contradictio in terminis*’, a contradiction in terms, a combination of two words whose meanings conflict with each other, and/or an idea that embodies a contradiction. It is not surprising that the term fell from grace. Walter Freeman, who popularized Psychosurgery in the USA, was, in 1960, banned from ever operating again, because of the disasters he was causing with his frenetic activities using his technique of transorbital or ‘ice pick’ lobotomy (i.e., hammering an instrument similar to an ice pick into a patient’s brain through their eye sockets). Edgar Moniz, who was nominated for the Nobel Prize by Walter Freeman, also fell in disgrace. In 2005 there was “an effort by the families of lobotomy patients to persuade the Nobel Prize committee to rescind the award that was given to Moniz” (Weiner, 2005)

The above example is a very good one for showing how harmful and dangerous may potentially be:

1. To use wrong names, because it might unconsciously *confuse the whole with one of its parts or the genre with the species*. Referring to neuro-surgery with the name of neuro-psychology a) is a huge logical error (even a mistake) in predicate logic, b) confuses the genre with the species, c) reduces the whole to some of its parts, and/or

d) confuses means with ends or –worse- take the means as an end in itself; which is a *logical perversion or an intellectual corruption in the context of End-Means Logic*. This is because, neural nets are part of the brain or the mind, but the way they function depends on other biological components as, for example, the production of hormones; which, in turn, depends on other biological processes. So, the brain's functioning does not depend just on its neural connections. It does not make any sense to reduce the biology of the brain, (organically related to the rest of the body) to just its internal connections; let alone reduce the psychic mind to the brain's neural nets. This is a usual and unfortunate consequence of reductionism, in general. This is the cause and/or effect of disciplinarians with intra-disciplinary inbreeding, hence, with impaired intellectual peripheral vision. Disciplines are partial descriptions of reality which is a whole. Consequently, *each disciplinarian should have; at least, a layperson's knowledge of the disciplines related to her/his. **This is why interdisciplinary communication is so ethically, intellectually, and pragmatically important**, and this is why disciplinarity and interdisciplinarity should be reciprocally related as it is shown in figures 6 and 7, in order to avoid extreme reductionisms and their inherent disciplinary inbreeding or incest. Consequently, why no more academic and scientific efforts are being made in order to increase awareness regarding this issue? This is the main purpose of this special issue and, potentially, of future special issues and multi-author printed books.*

2. To focus on just one discipline or –worst– on one sub-discipline. This may increase the probability of atrophying the intellectual peripheral vision or, even, to get blindsided regarding other disciplines that impact and are impacted by the one-dimensional disciplinary approach. This may certainly impact negatively the nature of human beings as individuals and as a society, in which problems, values, and objectives require multi-, inter-, and/or trans-disciplinary intellectual perspective. Intra-disciplinary academic incest or inbreeding may, certainly, be more harmful than any other kind of academic incest or inbreeding.

Some authors (e.g. (Stone, 2008) claim that psycho-surgery re-emerged with the new name “neuro-surgery”, This is not just a change in name in our opinion, but, naming things by their proper and correct names, which immensely helps in avoiding the conceptual confusions and the (mostly unintentional) logical errors, mistakes, and even logical corruption and perversions, that we briefly described in the point above. With regards to the model mostly followed (at least in the USA, e.g. The Massachusetts General Hospital) is mandatory to have a) “careful interdisciplinary screening” (Stone, 2008) by, at least, “psychiatrists, neurologists, and neurosurgeons” and b) and informed consent by the patient. Massachusetts General Hospital, for example, “involves the family in the informed consent process, but it is the patient

who must provide the formal written consent” (Stone, 2008). An increasing number of scientists and medical doctors emphasize in the necessity of consulting sources external to the organization that made the interdisciplinary screening. Even the United Nation’s convention conceives the review of an "independent external body" as a necessary condition for this kind of treatment and with regards to the validity of the informed consent (United Nations, 1991, p. 96)<sup>24</sup>. With regards to the external review, Alan A. Stone affirms that “Despite the interdisciplinary participation of psychiatrists, neurologists, and neurosurgeons, if they function within one hospital, there exist well-known psychological constraints and pressures for conformity.” (Stone, 2008). In our opinion, this external review would avoid not just organizational an economical interest to determine the kind of procedure to follow in such multidimensional and multi-disciplinary but also what we might call “*organizational or Institutional inbreeding or incest*” in potentially dangerous and, hence, unethical treatment. This institutional inbreeding is analogous to the much known academic inbreeding that might be produced by students who graduated from the same university to end up teaching in the same university in which they got their last degree or all their degrees; which would be worse.

Let us now present the third example provided by Robert M. Saposlky (2017, pp. 9-10):

The immensely high reproduction of the moral imbecile has long been established... Socially inferior human material is enabled... to penetrate and finally to annihilate the healthy nation. The selection for toughness, heroism, social utility... must be accomplished by some human institution if mankind, in default to selective factors, is not to be ruined by domestication-induced degeneracy. The racial idea of the basis of our state has already accomplished much in this respect. We must—and should—rely on the healthy feelings of our Best and charge them... with the extermination of elements of the population loaded with dregs.”<sup>25</sup>

This an example of the many texts Nobel Laureate Konrad Zacharias Lorenz wrote. He refers to non-Germanic races as “*moral imbeciles*”. Couldn’t he notice how “*immoral imbecility*” is what he wrote? *Is there a more adequate example of the intellectual monsters that intra-disciplinary incest may generate?* Is there any better example than this quote, written by Lorenz, as a conclusion inferred from applying, with intellectual blindsiding, the discipline of animal behavior, and a wrongly understood Darwinian evolution, to human beings races and, specifically, those with no Germanic descent?

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<sup>24</sup> Adopted by General Assembly Resolution 46/119 of 17 December 1991

<sup>25</sup> K. Lorenz, quoted by (Learner, 1992); referenced, in turn, by (Saposlky, 2017):

In 2015, the Austrian university of Salzburg “posthumously stripped Nobel Prize-winning scientist Konrad Lorenz of his honorary doctorate due to his fervent embrace of Nazism” (US-News, 2015). Isn’t that too little and too late, especially because he was granted the Nobel Prize in 1973? “This decision was made after his membership in the Nazi party was confirmed ... Lorenz only acknowledged being a member of the Nazi party after his membership application turned up long after World War II.” So, could we infer that Konrad Lorenz was stripped of his honorary doctorate because he *lied* for a long time and not because of conceiving human behavior as reduced to other animal behavior, from a one-dimensional and distorting intra-disciplinary perspective that moved him to one of the most racist attitudes, which supported the Nazi regime in justifying its crimes and genocides? Reading for the second time the quote above, any reader can notice the justification of genocide. Let us repeat: the above quote is just one of the many pages he wrote justifying Nazism and genocide.

In no way, I am trying to demerit Lorenz’s work or implying that it should not be read. I am not suggesting that every Nazi scientist has no merit and should not have the right to redemption. Neither am I saying that Lorenz was not a great scientist and probably among the best in the past century. On the contrary, what I am trying to convey is what Robert M. Saposlky (2017) tried to communicate: ***Even great thinkers and among the best may also suffer the intellectual deformities that may emerge as a consequence of intra-disciplinary inbreeding or incest. The consequences of extrapolating from one discipline to others, without a minimum of interdisciplinary communication and, hence, knowledge might create intellectual deformities and even intellectual monsters.***

One of the conclusions that Robert M. Saposlky (2017) made, after presenting the three above examples (among the many that might be presented) is that the three scientists mentioned above with their respective quotes

“[w]ere not obscure scientists producing fifth-rate science at Podunk U. These were among the most influential scientists of the twentieth century. ***They helped shape who and how we educate*** and our views on what social ills are fixable and when we shouldn’t bother. They enabled the destruction of the brain of people against their will. And they helped implement final solutions to problems that did not exist. *It can be more than a mere academic matter when a scientist thinks that human behavior can be explained from **only one perspective***” or discipline. (Saposlky, 2017, p. 10) [Italics and emphasis added].

## 7. Relating Disciplinarity and interdisciplinarity into Dialectic Wholes

The reality we perceive is a complex one and larger than the complexities that our brain can handle. Consequently, we filter what we perceive from reality, according to the objectives, the interest, and the urgency we have at the perception moment or time period. With this kind of experience, we try to make a sense of what we perceive and try to identify patterns and commonalities, in order to make the anticipations required for our survival. This leads us to a different kind of *commonalities*-based abstractions to *communicate* with ourselves (thinking) and with others (information and knowledge sharing). Because of different objectives, experiences and limited brain potentials, and intellectual skills, disciplines are created.

The frontiers of these disciplines are significantly arbitrary and dynamic, i.e. these disciplinary frontiers are fuzzy, continually changing, and interacting with each other. Intersections are one of the ways in which they are related. The other way to relate them is via *analogical thinking*. But, analogical thinking should be followed by logical thinking in order to validate and verify the generated analogies.

In our opinion, the three brilliant scientists mentioned above (as examples) were brilliant in their respective specialties which provided them with *potentially* useful analogies with other disciplines, but since they lacked adequate inter-disciplinary communication and due to a lack of intellectual interest for, and respect to, other disciplines, they were not able to validate and verify their analogies before applying them irresponsibly and unethically. I wonder if they had any positive attitude towards social responsibility or if they had ever had a crash course or read in Ethics or morality. Did Nobel Laureate Konrad Zacharias Lorenz have any idea about what is moral and what is not? If not, is it not irresponsible to refer to another human being as “*moral imbeciles*” just because they are from other races? Did he know or had the slightest idea about the meaning of the word “moral” before using it? If he had the slightest idea about the meaning of “moral”, how come he did not apply it to himself? How come he lied for several decades about his inscription in the Nazi Party? Was he really regretful about his many writings on racial hygiene to “scientifically” explain the necessity of Nazi eugenics? This is not a matter of ideological differences; it is a matter of science abuse or a scientist’s intellectual deformities caused by *intra-disciplinary incest, which is (in our perspective) the most dangerous form of academic incest*.

Inter-disciplinary communication decreases the probability of intra-disciplinary incest and this is an important reason (in our opinion) to make intellectual and pragmatically very explicit the necessity of synergistically relating disciplinarity and



interdisciplinarity into a “dialectic whole” as schematically is shown in Figure 6 and cybernetically relate this “dialectic whole” with Society at Large (Figure 7)

## 7.1. Dialectic Whole

We anticipated, in a footnote above, that we are using the phrase “dialectic whole” in two different, but related *senses of its meaning*, or different denotations of the related notion<sup>26</sup>. This notion has had different connotations and denotations, according to the ways in which have, historically, been used by different authors and thinkers. In this article, we are using two of them, one at the intellectual level and the other in the organizational domain. These two senses (denotations) are briefly described as follows.

**7.1.1. Concrete Dialectic wholes:** André Ong in (Dialectics of the Concrete: A Study on Problems of Man and World, 1976), referring to (Kosik, 1976, pág. 19), affirms that he

“makes helpful distinctions among three different conceptions of totality in the history of philosophy. The first is the *atomist-rationalist* conception that reduces reality to an *external sum of independent facts*. The second is the *organicist-dynamic* conception that reduces reality to a priority of the whole with little regard to the mediation of its parts. The third, a *dialectical* conception used in this chapter [Kosik’s book chapter] is a dialectical conception of totality that embodies both the whole and the **concrete** mediation of the parts in a process of mutual negation and elevation to a higher unity. Against an “empty,” “abstract” and “bad” totality, a dialectical conception of totality recognizes reality in its parts as individual moments of the whole, comprehends totality as an open, complex process of development and becoming that forms the whole”. [Italics and emphasis added]

Accordingly, in this sense of a Dialectic Whole, *we conceive interdisciplinarity as a dialectical conception of the totality of disciplines; which, via interdisciplinary communication, dialog, and (dialectics in its etymological Greek sense) makes possible processes of a Dialectic Conception of Totality of disciplines. This would mean the dialectic between the disciplines as concrete parts of the totality of disciplines. This perspective generates the emergence of Dialectic Whole, as a notion, a cognition, an idea associated with the world producing concrete facts that are*

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<sup>26</sup> We analyzed, elsewhere, the “notion of notion” (Callaos, 2013). Let us here briefly describe “notion” (cognition, an idea) as a set of related concepts, definitions, meanings and its respective senses. As a consequence a notion is not to be defined but described using its *connotations* and *denotations* which, in turn, originate the different concepts and definitions included in the described notion. We may add that this set may be a fuzzy set.

*interpreted in the different concrete disciplines according to different disciplinary rigor, logic, methods, semiotic systems, and epistemological values.*

In the case of a multi-disciplinary team, for example, a Dialectic Conception of Totality is what might be *conceived* by each of its individuals and/or consensually shared by the group with regards to the totality of the multiple-disciplines involved in the communication process. This kind of conception(s) is what may (and usually do) emerge in the concrete minds of academics/scientists/consultants/designers involved in a dialogical process, in the context of inter-disciplinary communication, as the one we just described in the paragraph above.

This totality is not necessarily a comprehensive one. It could (and usually is) associated with the set of all disciplines related to a given *concrete* problem, a *specific* phenomenon, or *concrete* objective. Different concrete conceptions may (and usually are) generated in different minds, but the interaction between the individuals (of a multi-disciplinary team, for example) would amplify what is common to the different conceptions and, hence, extend the communications bandwidth among the different individuals involved in the communication. A shared or a collective conception(s), or concept(s), may (as usually do) emerge from these intra- and inter-mental dialogical processes. In such a case, there usually are cybernetic relationships between self-communication and communication with others.

**7.1.2. General Dialectic Whole:** This sense of dialectic whole refers to a general totality, not a concrete one. Let us give some very important examples with the intention to trigger analogical thinking in the reader.

1. Niels Bohr's "Complementarity Principle", i.e. the particle-wave duality of light and electrons. It is not possible to observe simultaneously the properties of electrons and light as particles and as wave, but together present a more adequate or fuller description than anyone taken alone. The "Complementarity Principle" does not refer to a specific or concrete case but to general, abstract reasoning that refers to any particle-wave duality of light and electrons.

2. Werner Heisenberg's "Uncertainty Principle", i.e. each electron has a momentum and a position, but the more accurate is our knowledge regarding momentum or position, the less accurate is our knowledge regarding the other. Heisenberg does not refer here to any concrete phenomenon but to the totality of existing phenomena related to electron's position and momentum.

3. Fritjof Capra, a physicist and systems theorist, in the (*The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism*, 2000) associated Niels Bohr's "complementarity principle" and Heisenberg's "Uncertainty Principle", i.e. wave-particle duality and the electron's momentum-position duality to the Yin-Yang duality.

4. When Bohr received the Order of the Elephant, he chose to design his own crest. In his design, he associated his Complementarity Principle" (*Contraria Sunt Complementa*) to the Yin-Yang symbol of complementary opposites. Is it a mere coincidence this association? It is not possible to believe it. He was helped by a Chinese woman but the decision was his. Figure 9 shows the design that Niels Bohr ended up making regarding his crest. Is it a coincidence that at the center he included his "Complementarity Principle", along with the Yin-Yang symbol?

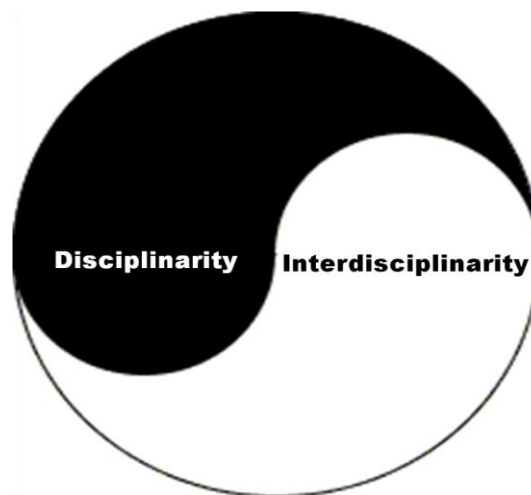


**Figure 9:** The design made by Niels Bohr for his crest, related to the Order of the Elephant that he received. Notice that his "Complementarity Principles" and the Yin-Yang Symbol are at the center of the design. Is this just a coincidence?  
*Copied from Michael Graf (The Artistic Genius of a Physicist, 2021)*

Quantum mechanics was associated with the dialectic whole represented by the notion and the figure of the Yin-Yang. We also would like to use this analogy and visual metaphor to represent *Disciplinarity and Interdisciplinarity, as a dialectical whole of the totality of disciplines. The interaction of the parts with the totality would be the interaction of each discipline with the totality of disciplines via inter-disciplinary research, education, and communication.*

This would mean that Disciplinarity and Interdisciplinarity are a complementary duality, polar opposites that require each other to exist as dynamic polar opposites. Heisenberg uncertainty principle may also support analogical thinking regarding disciplinarity and inter-disciplinarity, the more accurate is the knowledge of each side of the duality, the less accurate is our knowledge regarding the other.

Consequently, we suggest this sense of “dialectic whole” to interpret the general reality that, implicitly or explicitly, relates disciplinarity and inter-disciplinarity, as grossly represented in figure 10 and cybernetically represented by figure 6 and 7.



**Figure 10:** Interdisciplinarity, as dialectical conception of the totality of disciplines. Both contain and penetrate each other as illustrated in the Yin Yang visual metaphor and as analogous Yin Yang concepts and dialectic relationships between them.

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