Interdisciplinary Communication

Nagib CALLAOS
Universidad Simón Bolívar: USB
The International Institute of Informatics and Systemics: IIIS
www.iiis.org/Nagib-Callaos

and

Jeremy HORNE
President-emeritus, Southwest Area Division, American Association for the Advancement of Science (AAAS)
Inventors Assistance League

ABSTRACT

Communication is fundamental in scientific practice and an integral part of academic work. The practice of communication cannot be neglected by those who are trying to advance scientific research. Effective means should continuously be identified in order to open channels of communication within and among disciplines, among scientists and between scientists and the general public.[1]The increasing importance of interdisciplinary communication has been pointed out by an increasing number of researchers and scholars, as well as in conferences and roundtables on the subject. Some authors even estimate that "**interdisciplinary study represents the future of the university**."[2] Since interdisciplinary study is "the most underthought critical, pedagogical and institutional concept in modern academy"[3] it is important to think and reflect, and even do some research, on this concept or notion. Research and practice based reflections with regards to this issue are important especially because the increasing complexity and proliferation of scientific research is generating countless specialties, sub-specialties and sub-sub-specialties, with their respective special languages; which were "created for discrete local areas of research based upon the disconnected branches of science."[4] On the other hand, scientific, technical and societal problems are requiring multi- or inter-disciplinary consideration. Consequently, **interdisciplinary communication channels are being needed with urgency**, and scientific research should be integrated, not just in the context of its discipline, but also in the context of related disciplines. Much more reflection and research should be done on this issue. Research on adequate research integration and communication is urgently required, i.e. **meta-research efforts should be done in order to relate research results in an adequate and more useful way**. This meta-research effort might be done in the context of each particular research, and/or in the more general context of research methodology or philosophy. The purpose of this initial draft is 1) to foster informal conversations and possibly formal research, and 2) to give a very modest first step in this general context, making some reflections on the subject, reviewing some related literature and providing a very initial framework for the generation of more reflections and research on this important subject. We will try to achieve this purpose by means of presenting the most important characteristics of inter-disciplinary communication and contrasting them with intra-disciplinary communication. This essay is a short version of a larger one which will be completed in the future. Consequently, we will present a scheme summarizing the characteristics and the contrasts identified in this version of the essay and those which details are being worked out for an expanded version of this essay to be released in the near future. Our purpose in this first short version is to give a modest step in the direction of exploring the importance and the ways of inter-disciplinary communication, in order to foster more similar steps by other researchers, scholars or practitioners. This is an evolving working essay, where the process of writing it is as much a part of the object as the object, itself.

SCIENTIFIC RIGOR IN INTER-DISCIPLINARY COMMUNICATIONS

Communication among researchers from different disciplines, who are doing research with diverse methods and communicating their results in diverse specialized languages, is useful for intra-disciplinary communication, but it might be less useful for inter-disciplinary communication. If researchers tried to communicate their research results to the general public with natural, or everyday language, the problem of interdisciplinary communication would barely exist at all. However, communicating science to the general public has the cost of using a less precise language, which involves a *lower degree of scientific rigor*. To be rigorous in scientific communications, the researcher should restrict him/herself to a more precise disciplinary language and, in this way his/her audience will be restricted to those who are in the respective discipline and, consequently, understand his/her disciplinary language. To communicate scientific results outside their respective discipline, the language to be used should necessarily be less disciplined, less restricted, and more general. In most cases

[1] Kolenda, N., 1997, "Introduction" in Flower, R.G., Gordon T.F., Kolenda, N. and Souder, L. (Eds.), *Overcoming the Language Barrier: Problems of Interdisciplinary Dialogue*; Proceedings of an International Roundtable Meeting; May 14-17, 1997; Philadelphia: The Center for Frontier Sciences, Temple University; pp.1-4.

[2] Moran, J, 2002, *Interdisciplinarity*; London and New York: Routledge, Taylor & Francis Group, p.184. (Emphasis added)

[3] Liu, A., 1989, "The Power of Formalism: The New Historicism", English Library History 56, 4 (Winter): pp. 721-71. (Quoted by Moran, 2002)

[4] Dardick, I., 1997, "Monologues" in Flower, R.G., Gordon T.F., Kolenda, N. and Souder, L. (Eds.), *Overcoming the Language Barrier: Problems of Interdisciplinary Dialogue*; Proceedings of an International Roundtable Meeting; May 14-17, 1997; Philadelphia: The Center for Frontier Sciences, Temple University; p. 5.

there is no way to be highly rigorous and to address the general public. If the audience is to be enlarged, disciplinary language restrictions should be relaxed and, hence, rigor and preciseness will be decreased. The more general the audience is, the more general the language to be used should be. Thus, a *tradeoff* should be done depending on the audience to be addressed. This kind of problematic tradeoff is not new. When Descartes wanted to address the general public, he decided to write his philosophical text in French, instead of Latin, although the latter was required in his time for being rigorous in his argumentations and deductions. Actually, he wrote his basic philosophy in French for the general public and in Latin for the philosophers of his time. A similar dual solution might be one of the options used to solve the tradeoff problem that scientists are facing in the present time.

A similar problem is found with regards to interdisciplinary communication. But, in this case the tradeoff might be a different one. Interdisciplinary communications might not require lowering the level of scientific rigor as much as it would be needed for the general public, especially if the communication is among related disciplines in the same scientific field. A computer scientist in the area of programming languages, for example, might communicate with a software engineer with some disciplinary restrictions, although not with all the rigorous restrictions that he/she would require when communicating with another computer scientist in the same programming language field. But if this computer scientist wants to communicate with an electrical engineering he/she would probably need to remove more disciplinary restrictions to have an effective communication. More restrictions would probably need to be removed if he/she wanted to address a medical audience. And almost all disciplinary restrictions should probably be removed if he/she is looking to be understood by the general public.

Therefore, there are different ways to present research results according to the kind of audience(s) to be addressed. One way in which a scientist might communicate his/her research is to use the Cartesian approach, i.e. *to write in a disciplinary context and in an interdisciplinary one*. This might be done in the same paper, preceding the disciplinary presentation with an interdisciplinary one, or *vice ver*sa. In the latter case one way to do it (if the main objective is to address an interdisciplinary audience) is to increase the level of interdisciplinary communication in the paper, lowering its disciplinary precision and rigor, and to include appendixes in which technical and analytical presentations are done in more precise and rigorous language.

Interdisciplinary communication may also be achieved by means of writing to two or more disciplinary audiences. A very good example of this kind of interdisciplinary communications is found in Erwin Schrödinger's "*What is Life?"* where, according to Cecarrelli, Schrödinger "wrote an inspirational text calling for a cooperative action from the communities of physicists and biologists."[5] *Schrödinger combined vague text with precise notes* in order to address the book's two audiences, physicists and biologists. In physics passages he addressed biologists with a vague text and physicists with precise notes, and in biological passages with a vague text, he aimed at physicists, and with precise notes he addressed biologists. Schrödinger attended to the differences in his two audiences' biases. His treatment of animated objects with inanimate words and expressions was aimed to overcome physicists' bias, while his animation of the inanimate was aimed at the biologists' bias.[6] Thus, as Gross affirmed, "*how a text that said nothing new about either biology or physics could successfully persuade both biologists and physicists. This text [Schrödinger's What is Life? where precision and vagueness were adequately combined] became, in the words of molecular biologist Gunther Stent, 'a kind of Uncle Tom's Cabin of the revolution in biology that, when the dust had cleared, left molecular biology as its legacy'.*"[7] Schrödinger's *What is Life?* Is a very good example of how efforts to bridge disciplines, lowering the precision level adequately and decreasing the rigor when it is required in order to communicate ideas to other disciplinary communities might end up in *the generation of new knowledge, and it may represent the carburant of creativity , innovation and discovery***.**

Schrödinger's What is Life? is also an example on how interdisciplinary work including no original ideas can generate original ideas and new fields of research and theories. In a section titled ***The Value of Untrue, Unoriginal Science***, Leah Ceccarrelli presents several authors affirming that Schrödinger's *What is Life?* had no original ideas, even included some "outdated information," and "got so many of the facts wrong."[8] Nobel Prize Laureate Linus Pauling, for example, when referring to Schrödinger's *What is Life*? affirmed that "Schrödinger's discussion of thermodynamics is vague and superficial to an extent that should not be tolerated even in a popular lecture."[9] Cecarelli referred to several authors in concluding that "it is clear that novelty and factual accuracy were sorely lacking in Schrödinger book."[10] But, "Schrödinger's book should be evaluated because it *motivated so many scientists to engage in interdisciplinary research*."[11] Linus Pauling, among other authors, evaluated Schrödinger's *What is Life*? from a disciplinary perspective, while its real value was in the different ways the book inspired many physicists and biologists to engage in interdisciplinary studies and communication. Disciplinary values are not necessarily the same as inter-disciplinary ones. Disciplinary values are oriented to specific epistemologies and methodologies, while inter-disciplinary thinking, studies, and communications, while supported by disciplinary knowledge, are oriented to relating disciplinary knowledge and integrating knowledge and diverse intellectual activities. Analytical thinking mainly supports disciplinary research, while synthetic (probably via syncretic and/or eclectic) thinking is the basic support for inter-disciplinary intellectual activities and communication.

Interdisciplinary communication may also be achieved by means of writing different papers with regards to the same

[5] L. Ceccarelli, 1994, "A masterpiece in a new genre: The rhetorical negotiation of two audiences in Schrödinger's "what is life?" *Technical Communication Quarterly*, Volume 3, Issue 1, Special Issue: Rhetoric of Science. (Cited by Alan G. Gross, 1996, The Rhetoric of Science, Cambridge, Massachusetts: Harvard University Press

[6] Ceccarelli, 1994; Gross, 1996

[7] Quoted in Ceccarelli, L., 2001, *Shaping Science with Rhetoric*: *The cases of Dobzhansky, Schrödinger, and Wilson*, Chicago: The University of Chicago Press, p. 65 and in A. Gross, 1996, p. xxiii (emphasis added)

[8] Ceccarelli, 2001, ob, cit., p. 67, 68

[9] Linus Pauling, 1987, Schrödinger's Contribution to Chemistry and Biology ," in Schrödinger: Centenary Celebration of a Polymath, edited by C. W. Kilmister, pp. 225-33. Cambridge: Cambridge University Press. Quoted in Ceccarelli, 2001, ob, cit., p. 69

[10] Cecarrelli, 2001, ob. cit., p. 70

[11] Ibid.

subject, but with different degrees of rigor in order to present the same research results to different kinds of audiences. Academic merit should be given to each one of these papers because it will make research results more useful and because **it is *not easy* to write difficult things in *easy* terms**. It is not surprising that senior academics and Nobel Prize laureates are very well suited to write papers and books related to their scientific field and to their research results for the general public. This is the case of, for example, of Nobel Laureate Murray Gell-Mann's *Quark and the Jaguar*, where complex adaptive systems, quarks, quantum mechanics, superstring theory, biological evolution, etc. are masterly presented to readers from other disciplines and even to the general public. Only the discoverer of the quark can describe it so masterfully to the general public. Another example is the Nobel Laureate Ilya Prigogine's *The End of Certainty*[12], where the notions of time, chaos and the "New Laws of Nature" are so masterfully presented for the audience from other disciples and probably for a large general audience.

Let us repeat this again: *It is really not easy to write difficult things in an easy way*. This is because a deep *understanding* and an ample *comprehension* of the subject are both required to present to the general public or to other disciplines the disciplinary *knowledge* that results from scientific research. The person who only has a disciplinary knowledge without adequate understanding and comprehension of its meaning (and, hence, potential relationships with other knowledge domains) would certainly find it difficult to communicate his/her knowledge to other disciplinarians or to the general public.

Different means of interdisciplinary communication should also be searched and researched in order to present research results to other related disciplines, and more research should also be done in order to make research results understandable to the general public. Consequently, some kind of **meta-research** *should be conducted besides the research done in order to communicate its results outside of each respective discipline or sub-discipline.*

If scientific or technological research is to be oriented for interdisciplinary communication, it should be *related* not just to the associated research in its discipline or its sub-discipline, but it should also be *related to other disciplines*, i.e., it should be *integrated* into a more extended interdisciplinary context. In other words, such kind of scientific or technological research should have a **systemic insertion** in order to 1) avoid the increasing fragmentation of scientific knowledge, 2) increase and accelerate the usefulness of research results, and 3) enhance scientific, technological, academic, and industrial creativity. This takes us to the realm of the systems approach, or systems philosophy, which since its origins, emphasized the *relatedness of things and knowledge*, and it was continually being proposed as an integrative approach to the fragmentation of scientific knowledge

ANALOGICAL THINKING IN INTER-DISCIPLINARY COMMUNICATION

Analogical thinking and the use of analogy in communication is one of the most frequently mentioned means in systems science, or philosophy, due to its integrative possibilities, its effectiveness in interdisciplinary communication, and its creative potential in scientific research and technological innovation. "Analogies have been used to great effect in the physical sciences,"[13] as well as in mathematics,[14] and in problem solving.[15]

Analogy has also been effectively used in communicating science and technology to the general public, in relating effectively information systems analysts to users and, in general, in any kind of human communication. Some authors go further and assure that **analogy is at the very core of cognition.** Hofstadter, for example, asserts that "**a concept is a package of analogies**,"[16] and he is ready "to suggest that every concept we have is essentially nothing but a tightly packaged bundle of analogies, and to suggest that all we do when we think is to move fluidly from concept to concept—in other words, to leap from one analogy-bundle to another—and to suggest, lastly, that such concept-to-concept leaps are themselves made via analogical connection, to boot."[17] "The process of inexact matching between prior categories and new things being perceived…is analogy making par excellence."[18] This kind of matching processes is at the very core of interdisciplinary communication: to match prior categories, related to the researcher's discipline, to another one, to a new one for him/her, is an inexact matching process that requires analogical thinking and communication via adequate analogies, images, and metaphors.

Identification of analogies among disciplines is being increasingly favored by academic and research institutes. A progressively larger number of eminent scientists are supporting inter- and trans-disciplinary research and communication. Some of them decided to dedicate an increasing intellectual effort to this issue, as it is the case of the theoretical physicist, and Nobel Laureate, Murray Gell-Mann. He explains his perspective on this issue in the following terms:

> The philosopher F. W. J. von Shelling introduced the distinction (made famous by Nietzsche) between 'Apollonians,' who favor logic, the analytical approach, and a dispassionate weighing of evidence, and 'Dionysians,' who lean more toward intuition, synthesis and passion. These traits are sometimes described as correlating very roughly with emphasis on the use of the left and right brain respectively. But some of us seem to belong to another category: the 'Odysseans,' who combine the two predilections in their quest for connections among ideas. Such people often feel lonely in conventional institutions.[19]

[12] I. Prigogine, 1996, *The End of Certainty: TIME, CHAOS, and the NEW LAWS of NATURE*, New York: The Free Press

[13] C. Pask, 2003, "Mathematics and the science of analogies," *American Journal of Physics*, June 2003, Vol. 71, Issue 6, pp. 526. Accessed on Oct. 10, 2011 at http://ajp.aapt.org/resource/1/ajpias/v71/i6/p526_s1?isAuthorized=no

[14] Ibid.

[15] L. R. Novick,., and B. Bassok, 2005, "Problem solving," *The Cambridge Handbook of Thinking and Reasoning*, Cambridge University Press, pp. 321-350

[16] Hofstadter, D. R. 2001, "Epilogue: analogy as the Core of Cognition" in Gentner, D., Holyoak, K. J., and Kokinov, B. N., (Eds), *The Analogical Mind: Perspective from Cognitive Science*; Cambridge, Massachusetts: The MIT Press, pp. 499-538; p. 507. (Emphasis added)

[17] Ibid. p. 500

[18] Ibid. p. 504

[19] Gell-Mann, M., 1994, *The Quark and the Jaguar: Adventures in the Simple and the Complex*; New York: W. H. Freeman and Company; p. xiii

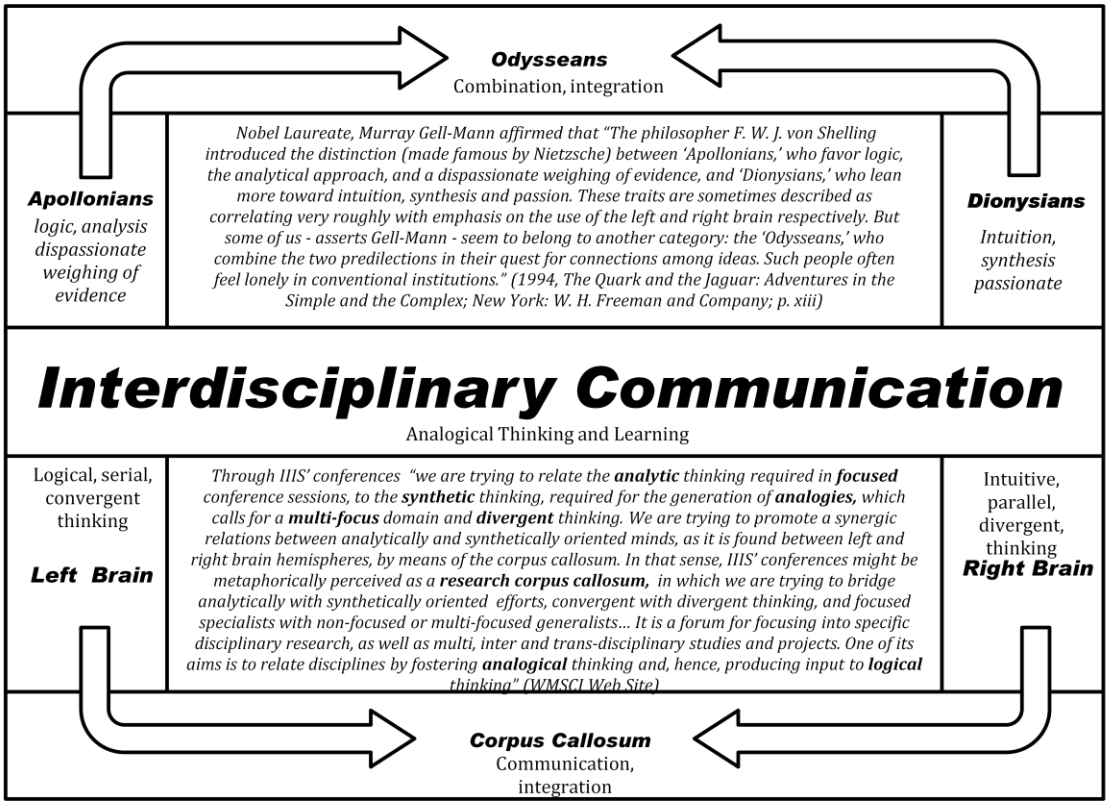

Figure 1

A metaphor we used to describe this kind of combination between the Apollonian and the Dionysian, this kind of connection between the Apollonian left brain and the Dionysian right brain, is the *corpus callosum* that actually connects them physiologically. This metaphor was used to represent the basic purpose of the yearly World Multi-conference on Systemics, Cybernetics and Informatics (WMSCI).[20] A basic purpose of these conferences has been described in the following terms:

> Through WMSCI conferences we are trying to relate the **analytic** thinking required in **focused** conference sessions, to the **synthetic** thinking, required for the generation of analogies, which calls for a **multi-focus** domain and **divergent** thinking. We are trying to promote a synergic relation between analytically and synthetically oriented minds, as it is found between left and right brain hemispheres, by means of the *corpus callosum*. In that sense, WMSCI conferences might be perceived as a **research *corpus callosum,*** trying to bridge analytically with synthetically oriented efforts, convergent with divergent thinkers, and focused specialists with non-focused or multi-focused generalists. … It is a forum for focusing into specific disciplinary research, as well as multi, inter and trans-disciplinary studies and projects. One of its aims is to relate disciplines by fostering **analogical** thinking and, hence, producing input to **logical** thinking.[21] (Figure 1)

It is a well established fact how important, even indispensable, analogical thinking is in human communications.[22] Analogies, images, and metaphors "are used by speakers because they meet the rhetorical needs of the particular context, and when perceived by listeners they activate familiar rhetorical-context categories."[23] Rhetoric here should be understood in its original sense, i.e. as effective communication. We showed[24] the importance of rhetoric in the communication between systems analysts and users in information systems development, especially in the respective activities of requirements engineering. Communication between information systems developers and users is not technical communication but human communication between technical professionals and users.

INTER-DISCIPLINARY COMMUNICATION VIA DIALOGUES AND CONVERSATIONS

Similarly, communication between scientists and the general public does not have to be overly technical in a specialized sense in order to be effective. Likewise, interdisciplinary communication is mostly human communication, so it could make good use of rhetoric by managing adequate analogies, images, and metaphors in order to be effective. This is a

[20] Other conferences organized by the International Institute of Informatics and Systemics (IIIS) have also as a main purpose to support Interdisciplinary Communication for which the metaphors described above illustrate this purpose.
[21] http://www.iiis2011.org/wmsci/Website/AboutConfer.asp?vc=1

[22] See for example Hofstadter, 2001, op. cit.
[23] Hofstadter, 2001, op. cit., p.520
[24] Callaos, N., 1995, "Enfoque Sistémico para el Diseño Educativo en Ingeniería de sistemas (*A systemic Approach for Educational Design in Systems Engineering*) in Metodología Sistémica de Sistemas: Conceptos y Aplicaciones (A Systemic Systems Methodology: Concepts and Applications), Caracas: Universidad Simón Bolivar, pp.514-542.

necessary condition, though not a sufficient one, for interdisciplinary communication, which is not mere information and symbol transference, as it is in normal human communication. **Learning** efforts should also be done in interdisciplinary communication from both the speaker and the listener. The speaker should engage in a **dialogue** with the listener by not reducing the presentation to a **monologue**, as it is usual in intra-disciplinary presentations of research results. The speaker should make a pedagogical effort, and he/she should engage in a learning process about the effective use of analogies from common life situations or from the discipline of the listener. In both cases, learning efforts might be required. On the other hand, the listener should make the mental efforts usually done by a student willing to understand and comprehend.

This kind of shared efforts in a dialogical communication (not the basically "monological" communication usually used in classical scientific conferences), is a necessary condition in interdisciplinary communication. An increasing number of researchers, professional practitioners, and scholars are stressing this fact. Helen Haste, for example, asserted in a roundtable meeting on "Problems of Interdisciplinary Dialogue" that

> "One of the key things here is recognizing that in the monologic method, and to some extent the engineering model has been monologic, is that there is something inside my head which is quite well structured. And I am going to carry this across, complete, into your head. It says it is my monologue which you are, as it were, recording verbatim. There is a sense that there is nothing going on except that you are taking, wholesale, and swallowing wholesale, what I give you from my head. So, my words are a representation, absolutely, of what is inside my head. And you are going to take on these words and make the same representation almost totally inside your head. Now, that isn't what happens. We have to look what dialogic means. **Dialogic means discourse**. It means, in fact, I am *negotiating* with you as I am speaking, in the sense that **I am trying to find ways of exploring language, exploring means of communicating, like metaphor, like analogy**, like interesting sentence adjectives, like allusion…**In the dialogic process we are trying to find the meaning not here and there but between us**…the process of communication is a process of negotiation, I think even in science. It isn't a process of zapping facts across the table."[25]

Since rhetoric and dialogic are both essentials to an adequate interdisciplinary communication, it might be thought that an actualization of the mediaeval *trivium* might provide a very good support for interdisciplinary communication. As it is known the mediaeval *trivium* included three areas for the education in human communication. These areas are: 1) grammar, the art and science of correct expression, 2) dialectic, the art and science of dialogue and argumentation, and 3) rhetoric, the art and science of communicating effectively. We showed[26] that an adequate actualization of the mediaeval *trivium* is important to include in the education of information systems engineers or analysts/synthetists. A similar reasoning might be applied to interdisciplinary communication. An adequate use of natural language is important for interdisciplinary communication, and it is necessary for communicating scientists with the general public. A natural language might be taken as one of the fundamental means of interdisciplinary communication, because it surely provides a **common** base through which such a **commun**ication might be supported. One of the "competing impulses" in English, for example, is the one "that aims to establish it as interdisciplinary center…"[27] "The assumption what words *mean* is itself interdisciplinary."[28] Natural language proficiency is an important issue when it comes to interdisciplinary communication. Communication via analogies, images, and metaphors are significant in this kind of communication. Likewise, it is with the dialogical approach how researchers and scholars from different disciplines **interact** with each other dynamically and dialogically, not monologously, in order to **learn** from each other in a fruitful cross-disciplinary interplay and collaboration. In usual scientific conferences, scholars and researcher attend basically to **inform** about their research results, and to be informed about other researchers' results. In interdisciplinary symposia, workshops, roundtables, etc. researchers, scholars, and practitioners attend to **participate in a cross-disciplinary co-learning** process. **Multidisciplinary conferences might be held in parallel, or collocated, with interdisciplinary events in order to support each other**. Researchers and scholars might be more productive and more useful to themselves and to other participants in such parallel events, where they might inform, and learn; get informed and teach. In this framework, **interdisciplinary tutorials** might play a very important role. They might not only support interdisciplinary communication, but they might also foster the communication between universities and industries, between the academic and the corporative worlds, between scientists, technologists, and practitioners, and even between scientists and the general public. Interdisciplinary communication, via interdisciplinary tutorials or other means, has a high potential in supporting the creativity required for the generation of new ideas, hypothesis, innovations, and/or unfamiliar possibilities by means of interdisciplinary analogies. Let us now focus a little bit on analogical thinking.

Table 1 schematizes the differences between inter-disciplinary and intra-disciplinary communications by means of contrasting their usual characteristics. This table collects the contrasting characteristics identified in this short version of the essay, as well as the extended version being worked out and to be promptly released.

INTER-DISCIPLINARY CONVERSATIONS

Academics, professionals and practitioners have increasingly been using the conversation format as an **alternative** to the conventional conference format. We think that the conversational format might also be used, not just as an alternative, but concurrently with conventional conferences in a way as to generate synergic relationships between both formats/models. If this combination is feasible, then the intra-disciplinary and inter-disciplinary communication might be

[25] Haste, H., 1997, "Dialogues" in Flower, R.G., Gordon T.F., Kolenda, N. and Souder, L. (Eds.), *Overcoming the Language Barrier: Problems of Interdisciplinary Dialogue*; Proceedings of an International Roundtable Meeting; May 14-17, 1997; Philadelphia: The Center for Frontier Sciences, Temple University; pp. 17-39; p. 25. (Emphasis added)

[26] Callaos, op. cit.

[27] Moran, op. cit., p. 17

[28] Forum: Defining *Interdisciplinarity*, 1996, *PMLA* 111, 2 (March), pp. 271-311; p. 280 (Referenced by Moran, 2002, op. cit.)

implemented simultaneously though the same meeting or conference.

In this short draft we will briefly describe the characteristics of each format or model, highlighting their opposite features,

Inter-Disciplinary Versus Intra-disciplinary Communication

Inter-Disciplinary Communication	***Intra-Disciplinary Communication***
Oriented to analogical thinking and learning	Supported by logical thinking and informing
Based mainly on Synthetic or integrative (probably via syncretic and/or eclectic) thinking	Based mainly on analytical thinking
Dionysians traits: leaning to intuition, synthesis and passion; and/or Odysseans traits : combining the two predilections in their quest for connections among ideas.	Apollonians traits: favoring logic, the analytical approach, and a dispassionate weighing of evidence
Systemic Insertion of research results	Systematic presentation of research results
Strategic intentional ambiguity is required for effective communication with multi-disciplinary audience.	Precision is valued
Tradeoff between rigor and adaptability to different disciplines, or multiple rigor versions according to the sought audience plurality	Maximization of rigor according to each disciplinary epistemological values and consensually accepted methodologies.
New relationships based of not necessarily original ideas are valued.	Original ideas are valued
Dialogical and/or Mono-Dialogical Orientation	Monological and/or multi-monological orientation generating potential debates.
Conversations and dialogues	Discussions, argumentations, and potential debates.
Homo dialogus: intellects relating to themselves by means of interacting with other intellects via dialogics.	*Homo argumentus*: intellect relating to others to win an argument by means of relating to themselves via logical thinking.
Reveals assumptions and premises for reevaluation.	Defends or attacks assumptions or premises
Require temporarily suspending one's beliefs and assumptions.	Require conviction in one's beliefs and assumptions.
Since enthymemes (syllogism in which one of the premises is not stated) are frequently used in conversations or dialogues, communication processes should include the identification of implicit or tacit disciplinary premises.	The identification of implicit or tacit disciplinary premises is not always a necessary condition for and effective communication
Frequently causes introspection on one's own position.	Frequently causes critique to other´s position
Dialectic as creative tension based on differences identification and opposite perspectives	Dialectic as argumentation, with which opposite opinions are confronted as a way of showing which one represent the truth, or which one is false; or as the sense of art or science of proving through logical argument.
Participants search for basic agreements and difference identification is used as potential learning sources in order create knowledge or extend the intellectual common ground.	Perceived differences are conceived as contradictions which should be faced by means of showing the truth or the falsehood of the contradicting thesis or ideas.
Multiple disciplinary dialects might lower communication effectiveness	Efficient communications through disciplinary dialects
Identification of synergic polar oppositions	Identification of contradictions.
Shared meaning and understanding	Truth/false identification and transference
Communicants submit their best thinking, knowing that other people's reflections might support their respective improvement.	Communicants submit their best thinking and defend it against challenges to show that it is right.
Non-hierarchical networked knowledge	Hierarchical relationships among disciplines
Non-lineal collective thought processes and explicit cybernetic loops	Lineal thought processes with few implicit cybernetic loops.
Communication is for knowing with each other and for knowledge creation.	Communication is usually one-way traditional publications and presentations, where the purpose is to *transmit* knowledge previously obtained, not to create it.
Collaborative	Frequently based on individual (or small groups) thoughts to be transmitted or to oppose other thought.
Finding common ground is usually the purpose.	Proving truth (or falsehood) in the context of a discipline is the usual purpose, which frequently is achieved via winning an argument.
Listening the other side in order to understand, learn, find new meanings, agreements, and common ground to improve communication.	Listening is usually for information apprehension and/or to identify flaws in order to counter-argument.
Extend and possibly changes a participant's point of view. Debate affirms a participant's own point of view.	Points of views are contrasted and discussed in order to confirm or disconfirm them
Participants assume that many people have different valid perspectives of reality and that together they can put them into a whole which would be a more adequate representation of reality.	Participants usually assume that there is one right perspective and that someone has it.

Table 1

suggesting the benefits of their possible integration, a methodology to design and implement this possible integration and the initial steps that might be taken in the context of reflection-action and design-action, which can end up in action-research projects.

To our knowledge, the largest meetings with the conversational format are The Fuschl and The Asilomar Conversations. The Fuschl Conversations have been organized every second year, for about 30 years by the International Federation of Systems Research (IFSR) and The International Systems Institute (ISI) has organized 25 meetings with the conversational format since the early 80's, being the Asilomar Conversations the core of them. The late Bela H. Banathy, former President of the IFSR and the ISSS (International Society for Systems Research), was the founder of these two series of meetings with the conversational format. The experience gathered in these conversations supported the organizing process of conversational meetings in the context of the conventional conferences organized by the International Institute of Informatics and Systemics (IIIS) since 2006.

Organizing conversational meetings in the context of conventional conferences might support the generation of ideas with regards to the possible synergies that might be generated my means of combining both models and the ways of implementing them with the purpose of 1) increasing the effectiveness of conventional conferences, and 2) *synergistically combining intra- and inter-disciplinary communication*.

The conversational format was conceived as an alternative to the conventional one in order to improve the effectiveness of scholar, academic, professional and /or practitioner meetings. Relating both of them in the same event might increase the effectiveness of both formats as well as inter- and intra-disciplinary communication.

T. G. Frantz, for example, affirms that The International Systems Institute (ISI), organizer of the Asilomar Conversations,

> … was born out of the recognition that academic, scientific and professional conferences seem to offer scant opportunities for colleagues to confer, to converse. Typically, a minority of participants deliver prepared presentations to a relatively passive majority. Except for brief Q & A opportunities, interchange among participants is rarely found on the official schedule... Presenting is almost always more prestigious than listening, and some presentations carry greater prestige than others. Traditionally, the prestigious experts disseminate pre-packaged new ideas to the others, who are encouraged to take home and use whatever they find valid or promising. Such hierarchical knowledge distribution systems greatly constrain us in addressing humanity's most pressing and complex issues, issues about which we are not merely concerned, but also outraged. Of course, at traditional conferences it is understood that scholars should approach issues objectively - without emotional involvement. Bela H. Banathy had a different vision for scholarly gatherings, one which could more fully harness the collective potential of groups…As Banathy puts it, "We aspire to reap the 'reflecting and creating power' of groups that emerges in the course of disciplined and focused conversations on issues that are important to us and to our society"."[29]

This "reflecting and creating power" of the conversational format might certainly support inter-disciplinary conversations and provide the participants of conventional intra-disciplinary communication with the possibility of having conversational meetings regarding inter-disiplinary issues.

The conversational and the conventional conferences formats oppose each other in several aspects. The table 2 below summarizes some of them. It might be thought that because of these opposite aspects of both models, the respective meetings have been held separated from each other. But, in our opinion, this opposition does not necessarily mean a **contradiction**; it might be handled as a **polar** one from a synergic perspective, or a complementary opposition**,** where each opposite requires each other to generate a **synergic relationship** or to produce positive **emergent properties,** where the whole is more than the sum of its parts. As it could be noticed, the conversational format would be more effective for intra-disciplinary communication, and the conventional format is more adequate to intra-disciplinary communication. Holding both kinds of academic communications might generate synergies providing disciplinarians 1) with the support to ***transmitting*** knowledge obtained by means of their research in a conventional format, and) with the opportunities for analogical thinking and learning via the conversational format, which might provide them with the opportunity of ***creating*** knowledge or ***generating*** new hypothesis to be tested in future research.

The opposite features of both kinds of meeting do not make any of them better than the other in an absolute form. Each model has its own advantages and disadvantages and, depending on the objective of the organizers, any one of them might be more or less adequate. If an appropriate combination is made of both of them we might amplify the advantages of each model and diminish its disadvantages. To identify some kind of an adequate combination, some tradeoffs should be made. These tradeoffs are, by their very nature, more subjective than objective, so they require subjects to provide them with the objective of finding the most consensual one.

[29] T. G. Frantz, T. G., 2006, "The ISI Story & a Warm Welcome to All Who Share Our Vision." In http://www.isiconversations.org/publications/pub_welcome.pdf

Conventional Conferences Versus Conversational Format

	Conventional Conferences	Conversational Format
Input	Paper based on a **solution** or an **answer**, which will be presented by an **individual** (its author).	A **problem** or a **question**, which will be addressed by a **group**.
Output	**Knowledge or information** communication.	Sharing of **Knowledge, reflections, ideas and opinions in multi-directional** communication.
Flow of Information	Basically **unidirectional**.	**Multi-directional**.
Sequence	**Serial**: one presentation after another, in a **lineal** format.	**Serial/Parallel:** multiple short presentations by each individual interacting with similar shorts presentations of others in **a non-lineal** interchange of ideas.
Cybernetic Loops	None or very **low level** of feedback in the small time period of questions/answers.	**High levels** of feedback and feedforward loops in a highly interactive environment.
Formal/Informal	Papers are presented in a **formal** environment and informal interaction is limited to coffee breaks.	More **informal** sharing of ideas and reflections with more possibilities of group creativity and ideas emergence.
Creativity	**Individual (**or group creativity) **previous** to the meeting.	Group creativity during the meeting nurturing and being nurtured by the individuals in the group in positive loops of feedbacks.
Order	**Pre-established fixed** order of papers presentations. **Plan-based** order.	**Post-established, emergent and dynamic** order. **Rules-based** order.
Process	Systematic	Systemic
Implicit general Objective	Oriented to **efficient** knowledge or information communication	Oriented to **effectiveness** in knowledge communication, sharing of ideas and reflections, solving problems, answering questions, achieving consensual designs, etc.
Whole/Parts	The whole is basically **equal** (or sometimes even less) to the sum of its parts	The whole is basically **more** to the sum of its parts
Guiding Metaphor	**Mechanism**	**Organism**
Methodological and Epistemic Approach	Mostly, but not uniquely, oriented by Reductionism and Mechanicism	**Oriented by the Systems Approach and its Pragmatic-Teleological epistemology and methodologies.**

Table 2

REFERENCES

Callaos, N., 1995, "Enfoque Sistémico para el Diseño Educativo en Ingeniería de sistemas (*A systemic Approach for Educational Design in Systems Engineering*) in Metodología Sistémica de Sistemas: Conceptos y Aplicaciones (A Systemic Systems Methodology: Concepts and Applications), Caracas: Universidad Simón Bolivar, pp.514-542.

Ceccarelli, L., 1994, "A masterpiece in a new genre: The rhetorical negotiation of two audiences in Schrödinger's "what is life?" *Technical Communication Quarterly*, Volume 3, Issue 1, Special Issue: Rhetoric of Science.

Ceccarrelli, L., 2001, *Shaping Science with Rhetoric*: *The cases of Dobzhansky, Schrödinger, and Wilson*, Chicago: The University of Chicago Press.

Dardick, I., 1997, "Monologues" in Flower, R.G., Gordon T.F., Kolenda, N. and Souder, L. (Eds.), Overcoming the Language Barrier: Problems of Interdisciplinary Dialogue; Proceedings of an International Roundtable Meeting; May 14-17, 1997; Philadelphia: The Center for Frontier Sciences, Temple University

Forum: Defining *Interdisciplinarity*, 1996, *PMLA* 111, 2 (March), pp. 271-311. (Referenced by Moran, 2002)

Frantz, T. G., 2006, "The ISI Story & A Warm Welcome To All Who Share Our Vision." In www.isiconversations.org/publications/pub_welcome.pdf

Gell-Mann, M., 1994, *The Quark and the Jaguar: Adventures in the Simple and the Complex*; New York: W. H. Freeman and Company.

Gross, A. G., 1996, The Rhetoric of Science, Cambridge, Massachusetts: Harvard University Press.

Haste, H., 1997, "Dialogues" in Flower, R.G., Gordon T.F., Kolenda, N. and Souder, L. (Eds.), *Overcoming the Language Barrier: Problems of Interdisciplinary Dialogue*; Proceedings of an International Roundtable Meeting; May 14-17, 1997; Philadelphia: The Center for Frontier Sciences, Temple University; pp. 17-39.

Hofstadter, D. R. 2001, "Epilogue: analogy as the Core of Cognition" in Gentner, D., Holyoak, K. J., and Kokinov, B. N., (Eds), *The Analogical Mind: Perspective from Cognitive Science*; Cambridge, Massachusetts: The MIT Press, pp. 499-538.

Kolenda, N., 1997, "Introduction" in Flower, R.G., Gordon T.F., Kolenda, N. and Souder, L. (Eds.), *Overcoming the Language Barrier: Problems of Interdisciplinary Dialogue*; Proceedings of an International Roundtable Meeting; May 14-17, 1997; Philadelphia: The Center for Frontier Sciences, Temple University; pp.1-4.

Liu, A., 1989, "The Power of Formalism: The New Historicism", English Library History 56, 4 (Winter): pp. 721-71. (Referenced by Moran, 1989)

Moran, J, 2002, *Interdisciplinarity*; London and New York: Routledge, Taylor & Francis Group.

Novick, L. R., and Bassok, B., 2005, "Problem solving," *The Cambridge Handbook of Thinking and Reasoning*, Cambridge University Press, pp. 321-350.

Pask, C., 2003, "Mathematics and the science of analogies," *American Journal of Physics*, June 2003, Vol. 71, Issue 6, pp. 526

Pauling, L. 1987, "Schrödinger's Contribution to Chemistry and Biology ," in *Schrödinger: Centenary Celebration of a Polymath*, edited by C. W. Kilmister, pp. 225-33. Cambridge: Cambridge University Press.

Prigogine, I., 1996, *The End of Certainty: TIME, CHAOS, and the NEW LAWS of NATURE*, New York: The Free Press