

INSTITUTE FOR THEOLOGICAL ENCOUNTER
WITH SCIENCE AND TECHNOLOGY
(ITEST)
NEWSLETTER

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For Your Calendar:

The October 9-11, 1981 Conference will discuss the topic of "Warfare in the 1990's." We are assembling a panel of speakers who will consider: the role of science in military planning; the technological state of warfare in the next decade; the theological question "whether, in the age of nuclear, biological, chemical, light and particle warfare, a nation may legitimately defend itself, and, if so, how?" To this date we have Profs. William O'Brien (Georgetown) and James Johnson (Rutgers) to address the theological question and Bishop John O'Connor (Catholic Military Vicar) to consider the state of the technology. We are still seeking the fourth speaker.

The March, 1982 Workshop will consider the topic of the impact of contemporary science and technology on the survival of the nation state. More details on this Workshop will be given in subsequent Newsletters.

ITEST Notes:

The March 13-15, 1981 Workshop on "The Patenting of Recombined DNA" was a significantly successful meeting. We want publicly to thank our "faculty", Mr. Cusack, Mr. Saliwanchik, Fr. Schall, S.J., and Dr. Yannarell, for their excellent help. The Proceedings should be available for our dues-paid members early in the fall.

The Proceedings of the October, 1980 Conference on "Government Intervention and Regulation" are now at the printer. They will be sent to the dues-paid membership as soon as they are printed. The members have also recently received a copy of "ITEST Monograph, 1981."

We remind those who have not yet renewed their membership to do so soon. The Proceedings of the 1981 Workshop (Patenting of Recombinant DNA) and Conference (Warfare in the 1990's) will be sent only to dues-paid members for 1981. Do renew soon if you have not already done so.

NOTICE:

Father Patrick Dolan of St. James Catholic Church, 1826 Edenside Avenue, Louisville, Ky. 40204, a chemist and long-time member of ITEST, issues the following challenge to ITEST members:

- (1) to use their scientific and technical backgrounds to transform theology;
- (2) to publish articles along these lines.

Father Dolan remarks: "There are many topics available, such as 'Vector Analysis and the Procession of Persons in the Trinity as a Resolution of the Filioque Controversy.' There is also the possibility of a paper on 'How Electromagnetic Theory Can Illumine the Generation of Son from Father in the Nicene Creed: God from God, light from light?' Or, 'Metabolic Development of the Adolescent as a Necessary Prerequisite for the Fullness of the Incarnation in Jesus Christ.' Or, finally, 'Genetic Transmission of Original Sin.' I am already using understandings from chemistry in an explanation of transubstantiation.

"I mean this as a real challenge. I offer a \$100.00 prize for the best published article each calendar year on any science-to-theology topic like the above examples. Articles on evolution or medical ethics will NOT be eligible. I ask that you forward this information to the ITEST membership, as they are the only group eligible for this prize."

Please send any manuscripts to Father Dolan at the address given above.

SOME REFLECTIONS ON COMPLEMENTARITY

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(Lucien Morren is Professor Emeritus of Engineering at the Catholic University of Louvain, Belgium. This was presented as a talk for an Anglican community in Brussels, Belgium.)

I have to begin with a request. Whereas a good hundred technical meetings held all over the world have acquainted me with the English language in my own professional fields, namely electrical measurements and photometry, it is the first time that I have to speak in English on the subjects to be dealt with tonight, so I beg your indulgence.

This was not, however, a reason for declining the kind invitation to deliver this small lecture. On the contrary, I welcome it as two of my main concerns are simultaneously involved. For over 40 years, my wife and I have been thoroughly interested in ecumenism and, on the other hand, the very subject on which I shall speak has been at the centre of my reflections, as a Christian and as a scientist, for an equal span of time.

But what is this subject? It may be summarized in one word, complementarity. I was invited to lecture, quoting the exact terms of a letter, on "Christianity from the point of view of physics, especially the latest developments in physics." There is no question of my covering all these latest developments. Firstly, I am not competent enough, being an engineer and not a true physicist and, secondly, the global subject is too broad by far to be dealt with in half an hour. I thus much prefer to avoid dispersion and, as already announced, to concentrate on complementarity, a subject which starts from modern physics but which, by analogy, allows insights into much higher spheres.

What do we mean by complementarity? In the strict sense as presently used in physics, it is a notion born in the 1920s. Its fathers are such major physicists as Louis de Broglie, Niels Bohr, Werner Heisenberg.

But, in order to understand any birth, we have to take some steps backwards and to undertake, as quickly as possible, a survey of the evolution of fundamental physics over the previous century. Fortunately, we may do it without using other terms than those which belong to the general culture of the age we live in.

By fundamental physics, we mean the study of the basic entities of the universe. Among these, light is a particularly fascinating one. Already in the XVIIIth century, its nature was a subject of dispute, namely between Newton and Huyghens: does light have a corpuscular or an undulatory nature? In other terms, is it made of tiny particles or of waves? For over a century, the most distinguished scientists were divided on this matter for there were arguments for both points of view.

But a choice had to be made. Indeed, the two representations are not only quite different but mutually contradictory. A corpuscle is something well located in space, it implies a discontinuity. A wave is something necessarily extended in space, something continuous: let us consider the trivial image of the waves progressing on a pond when a stone is thrown in the water; it would be strictly contradictory to restrict such a wave to a single point, moving up and down without involving its environment. We just spoke of waves progressing: we may count the number of undulations passing by a given point in one second and we define thus a concept of prime importance associated with any wave, its frequency. Now, such a concept is completely foreign to the representation of a corpuscle which, of its very nature, exhibits no periodic character.

For years, the state of optics was such that both representations could be adopted, the one or the other of course. But, at the beginning of the XIXth century, experiments carried out by the French physicist Augustin Fresnel resolved the question. The phenomenon of interference which he studied could only be explained if light were a periodic entity, thus possessing the nature of a wave. Further experiments confirmed this view and, for the remainder of the century, the undulatory character of light was no more disputed.

On the other hand, the same XIXth century had seen a spectacular development of our knowledge about electricity, ending in the discovery that all electric currents resulted from the movement of tiny elementary charges or electrons. Thus the electron became another fundamental entity of the universe and the model for a corpuscular nature.

Just before 1900, the two representations seemed well adapted to fit many other discoveries: all the atomic world had the corpuscular character for which the electron provided the paradigm. And all the newly discovered rays, the X rays, the ultra-violet and infra-red radiations, up to the radio waves of Hertz predicted by Maxwell, appeared to constitute, with light, one large family of electromagnetic waves differing only by the ranges of their frequencies.

But nature is not necessarily made for the comfort of physicists. Already some difficulties between theory and experiments were noticed. But a real crisis burst in the very first years of our century. Precisely in 1900, the major work of Planck meant that the energy flow carried by light had to be conceived in a discrete form or, as Planck said, had to be distributed in a number of quanta. In other words, a corpuscular aspect had to be reintroduced for light. But the most powerful argument in favour of this corpuscular aspect was introduced in 1905 by Einstein. He found the law accounting for the curious properties of light when interacting with matter in the so-called photoelectric effect, that is the

liberation of electrons when light falls on some materials. The explanation rests entirely on the hypothesis that light is made of separate grains that he called photons. The word is now well known and the photoelectric effect still more so since it lies at the very root of the operation of the exposure meters used throughout the world by amateur photographers.

After these discoveries by Planck and Einstein, did the physicists abandon the wave concept for light? Not at all, for there were always well-known phenomena such as diffraction and interference which compelled them to retain the undulatory view. It was still impossible to explain them if light consisted only of photons. Thus science was facing an apparent contradiction.

This uncomfortable situation lasted for about twenty years. It was only in 1924 that Louis de Broglie, in his historic thesis submitted for his Degree of Doctor in physics, dared to associate both the corpuscular and the wave characters of light in a single mathematical formalism. His work was the starting point of quantum mechanics, further developed by Heisenberg, Schrodinger, Dirac and others. But beware! The discomfort had not disappeared, it had merely been modified. On the one hand, physicists could be satisfied for they had no longer to choose between two theories, is light made of particles or is it a wave? The fundamental contribution of de Broglie is to remove this small word or and to replace it by another little word and: light is both corpuscular and undulatory. But the new situation is perhaps still more amazing because the link between the two aspects is purely formal, mathematical, they remain absolutely unreconcilable with regard to their representations. It was precisely to characterize such a situation that Bohr introduced the word "complementarity" as meaning the necessary conjunction of two aspects which remain apparently contradictory.

It may be argued that we meet here one of the most important revolutions brought about by the developments of physics in the beginning of the XXth century (and, in this respect, we should also include relativity): up to this period, science was seen as a sphere of clear understanding steadily growing and reducing an external domain of the unknown. With complementarity and, up to a point also, with relativity, it is within science, internally and thanks to the most outstanding breakthroughs, that powerful enigmas emerge. Of course, as de Broglie puts it himself (I give a free translation), "there is no evidence that we may describe a physical entity by only one image or only one concept of our mind"; and he adds: "Both aspects, corpuscular and undulatory, are like the sides of an object that we may not contemplate at one and the same time; we have instead to consider each one in turn to get a complete description."

With complementarity, we may fully agree with the saying of Norbert Grelet, a French biologist, "L'objet de la science est devenu le sujet du mystere", "The object of science has become the subject of mystery".

Of course, in science, a riddle is not only a mystery, it is also a spur to further research. Up till now, however, all efforts to solve the riddle have proved to be failures. Still more important, complementarity has extended its scope. De Broglie had already dared to suggest that the theory could be applied to all fundamental entities, not only to light and the associated electromagnetic waves but to the so-called corpuscular entities, such as electrons as well, suggesting that these would also exhibit an undulatory aspect. Three years later, new experiments confirmed such daring views: Davisson and Germer obtained diffraction patterns with beams of electrons, showing clearly that these were guided by associated waves, in conformity with the mathematical predictions of de Broglie who, soon after, was awarded the Nobel prize.

And Bohr was probably the first to suggest that complementarity might find an important application in biology, in helping to understand the twin aspects, physico-chemical and specifically vital, of the phenomenon of life.

Here, precisely, ways seem open to a generalized complementarity which, for me, may well constitute the strongest argument in favour of the assumption that, with such a perspective, a fundamental structure governing all beings in the universe has been disclosed. If the assertion is valid, whatever refinements may be introduced by further research, it is quite unlikely that complementarity, as a structure, will ever be eliminated. Indeed, the elementary building blocks of physics are not the only entities showing a dual, or better a dichotomic structure. This appears to be true for all other beings but, of course, under appropriate forms for each level. Let us think of ourselves: at our level, a complementarity between an animal nature and a spiritual one is so obvious that many philosophers, like Descartes, were led to a dualistic vision of man. However, such a vision did not have due regard for our fundamental unity which, nowadays, is very deeply felt. We are more and more conscious that there is no thought without a brain, that is without a physiological organization. But the link between the mind and this material organization, how they are associated and how they work together, remains the most colossal mystery. Indeed we face in ourselves a complementarity in the strict sense of the word as defined by modern physicists, namely a necessary conjunction of aspects in spite of the fact that we have no representation for their association.

It is then not very difficult to find similar appropriate structures for the intermediate levels of evolution. Are there, however, suitable concepts for characterizing at each level the twin aspects on which the corresponding beings rest? It seems that a positive answer may be given to the question by using the concepts of "substratum" on the one hand, and of "information" on the other, this term "information" being understood as "giving form to" but also, progressively, in the usual sense of providing knowledge and meaning. Already at the lowest level of the elementary physical entities we started from, there is no difficulty in considering the corpuscular aspect as the substratum, whereas the undulatory aspect may be linked with information since the wave plays the role of a "guide" for the particle, even if here we have to put the word "guide" in inverted commas.

Treading in big steps, for we are short of time, we may now draw up a table of the essential levels to be distinguished along the main axis of evolution. (See page 6 for table)

Such a table brings to light the fact that, at each level, it is the preceding one as a whole which constitutes the new substratum aspect while the emergence of the quality characterizing the level appears on the information side.

But, let us stress this strongly, if there are always twin aspects, there is no duality in the sense of separation: at every level, the conjunction of the two mutually opposite aspects builds up a unity, even if we don't know how the link works.

When, through a deepening of his knowledge, man approaches the ultimate basis of the structure of creation, a Christian should not be astonished if he also faces something of the transcendancy of the Creator. Complementarity appears to be fundamental for the natural order. The temptation then arises to look beyond the bounds of nature into spheres beyond those of science for some illumination to be thrown on the deep significance of such a mysterious structure.

TABLE

| level | substratum aspect | information aspect |
|--------------------------------------|------------------------------|------------------------------------|
| elementary physical entities | corpuscles | waves |
| atomic and molecular | elementary physical entities | interactions (affinity) |
| biological (beginning with the cell) | molecules (macro-molecules) | the (informatory) organization |
| developed living beings | the functional body | the (animal) psyche |
| man | the animal structure | the mind, the reflexive conscience |

I have just spoken not only as a scientist but also as a Christian. By these spheres beyond the scientific ones, we mean of course the realm covered by thought applied to faith, that is the realm of theology. But then, before going further, it is absolutely necessary to express some warnings because the passage may be perilous. I thus declare that there is no question of concordism which fails to recognize the necessary distinctions between the natural and supernatural orders. But, on the other hand, what will be absolutely required is the sense of analogy. And this is the right word because there is no analogy between two things if they have no resemblance but neither is there analogy if they do not differ in some way from each other. So let us be sure that we never forget the required distinctions. Past experience has shown the importance of laying stress on this point.

This being said, what is striking when we enter into these higher spheres just mentioned, is that all the fundamental Christian mysteries demonstrate the very structure of complementarity, the very paradoxical structure based on antinomies in conjunction. It is firstly in God Himself, the association of the One and the multiple, the Unity and the Trinity. It is in Christ, the union of two natures in a single person. It is in Mary, the conjunction of motherhood and virginity. It is in all our actions, in the necessity to assert both our freedom and the divine motion. But the most troublesome complementarity may perhaps appear when we look at the Cross where God is at one and the same time free and bound.

Without using the term, it appears thus that theology discovered complementarity centuries ago. In attempting to grasp the wholeness of the truths they were aiming to formulate, theologians were always faced with the necessity of associating opposite concepts. And, as we have seen it, modern physicists find themselves in a similar position. Let us but quote this sentence: "The more or less schematic

idealizations that our mind builds up are susceptible to representing certain sides of things but they entail limits and their frames are too rigid for grasping all the richness of reality." Who wrote this? It could be a theologian speaking about the conditions of his own work but it is again the physicist de Broglie. The very possibility of such a question illustrates in the most appropriate way the structural analogy of statements both in theology and in science.

From here, we may draw a first lesson of a pedagogical character which might nowadays be quite useful: by compelling us to admit this association of apparently contradictory concepts in order to attain a fuller and richer insight into the natural sphere, complementarity may serve as a sign removing obstacles for the acceptance of religious mysteries. At least, it takes away any right to reject them on grounds of apparent contradiction. We know that we have to keep aspects together even when we don't clearly see the link between them.

But complementarity may lead us to much more positive views than simply removing obstacles. If the previous developments are accepted, that is if a structure of complementarity is really to be found in all beings at any level in their hierarchy, then a new light may illuminate the traditional patristic theme of the Creation being the Image of the Creator. In some way, all Creation and not only man, who is of course its pinnacle, then appears as a "reflection" of Him who is "par excellence", pre-eminently, the Complementary Being (with capital letters) having united in His single person the creative and created natures. Is it so astonishing that the Creation retains the mark of its Creator? That was anyway the vision, mostly forgotten today, of many Fathers of the early Church, especially in the East. Visitors in Venice may admire at the extreme right of the porch of the basilica of St. Mark, under the cupola, the byzantine mosaic of the Creation. In one of its panels, the globe of the earth reflects like a mirror the face of Christ.

Modern science, through complementarity, provides a powerful argument for such a vision. Complementarity operates here as a sign, like all arguments pertaining to the role of reason and understanding in faith. At this stage, we do not have enough time to consider in detail the particular way of acquiring knowledge through the understanding of a sign, that is, through the understanding of the meaning associated with a significant fact. For we may briefly define a sign as a fact expressing a significance, expressing a meaning. This form of knowledge is fundamental for the theology of faith, for it respects the necessary distinction between the divine and the natural orders, it respects the apparently opposite requirements of grace, will and reason in faith. To develop this point would be out of our present scope. Let us but stress that, if a sign is a fact expressing a meaning, we meet again in it the very structure of all our complementarities.

Yes, the structure of complementarity is met every time we approach the divine or the ultimate. In speaking of it, we used the expression "apparent contradiction". The word apparent is very important here. There is indeed no question of introducing the contradiction into the realities themselves; but it reminds us that the richness of reality exceeds the limits of our minds. It is a token, negatively, of our finite nature and, positively, of transcendence.

Complementarity acts as a sign, illuminating, at least for me, a symbiosis, a living together, of the spheres of the profane and of faith and it may still be applied to throw light on other Christian paradoxes. I much prefer in this respect the word symbiosis to synthesis which might be understood as an amalgam without due regard to the necessary distinctions.

I hope I have succeeded to some extent in showing how and why complementarity has coloured my whole vision, as a scientist and as a Christian. It remains for me to thank you for your attention.

PROFESSIONALS AS ENABLERS

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Society has two systems of organization for bringing people together to get the work done that society needs doing; the trickle-down structures which represent the classical, hierarchial approach to stability and control and the percolation-up philosophy of self-reliance which, while identified with creativity, has not been permitted to develop its potential. The individual and the family embody this principle, but the family is shrinking and fracturing as a relational support for the individual.

Even with computers, the formal or structured economy is becoming too complicated to muster the enthusiasm of individuals in the solution of global problems by local solutions. We do need large organizations for certain of our goods and services. The basic problem is that the individual needs to develop self-reliance and dignity resulting from responsible actions. Therefore, he not only needs time-honored freedom but even more important now, he needs to be part of community groups and experience deep, relational activities. The imperative of this need is the demise of the large family as the building block of civilization.

Our aim then would seem to be the preservation of the present formal economy while gradually strengthening the spontaneous or informal economy, with its non-cash employment and emphasis on caring. One would also encourage the creation of new, small industries that now tend to be swallowed up by the organizational giants, on quite questionable grounds of efficiency.

ENABLING NETWORKS

Granted the above argument, it would seem appropriate for the UME (University Ministry in Education) on Theological Dialogue with Science and Technology to move professionals in the direction of creating networks (as distinct from organizations). These networks would include enabling activities, to develop the leadership capacity of all individuals, as part of what it means to be a professional.

TO THE STATUS OF SERVANTS

Evidence abounds on the professional's aim to be part of a privileged group rather than go for the servant role. (Our very specialized vocabularies attest to this situation). Does the physician push for health care and the eventual decrease of the need for his services? Does the lawyer spend a proportion of his time teaching the layman how to prepare his own will? Does the church minister prioritize his weekly activities as if he feels that his mission is to make ministers of all believers? It is certainly not natural for one to work himself out of a job, but a larger motivation than personal gain should be encouraged. Certainly loving one's enemy doesn't come naturally, either.

ACADEMICIANS ARE DOUBLY DISLOYAL TO SOCIETY

We academicians criticize professionals working in industry as being loyal first to the company and then only secondarily to the public, as if profit was a bad goal. We academicians are often members of a national professional-society which commands our loyalty. This loyalty is to a national (or even international) peer group and to its research effort, with very little emphasis on loyalty to our teaching function. The small encouragement of loyalty to our institution is compounded by the institution's small encouragement to apply our knowledge to the community around us.

ADD ENABLING TO PROFESSIONAL CODE

Professionals always tend to be inward-looking. They are committed by code to long-range goals (career planning), a depth of specialized education, an honesty in logical thinking (whatever the presuppositions), the development of a body of knowledge, a dedication to teaching the young and service. The key term is service, but the interpretation is short-range - to work long hours to give those in need of the benefits of our services. There is trivial emphasis on long-range leadership training as enablers rather than the short-range authoritarian (colonial) assistance. The emphasis on service in the future must be (1) to the immediate need and (2) to leadership training to eliminate the need. This has the goal of making leaders of all people - developing their self-reliance and dignity to make them responsible citizens.

HONESTY IN INSTITUTIONAL PUBLIC RELATIONS STATEMENTS

Professionals are involved in organizations, in which stated goals and operational goals are usually at variance, particularly in these days of strong public relations departments. (The churches may also be criticized at this point). Perhaps a role of the professional (and likely the normative role of the Church) is to encourage organizational evolution in which operational goals are continually scrutinized and upgraded to better match the stated goals. Of course, in the process, the stated goals can themselves also be improved when found to be the limiting factor.

ACADEMIC PROFESSIONALS IN TWO TIME FRAMES

The academic administrations could do much to encourage the teacher to divide his time between ministering to need and to the elimination of need. Teachers usually act as "autonomists", not overlapping into each other's fields, letting students do their own integrating (not always bad!). A simple change in employment policy could make a world of difference. If the administration would not only look at the applicant's technical capability, but also at his motivation and experience in (1) relating to other disciplines or (2) applying theoretical knowledge to the community situation, then faculty would be encouraged to seek holistic approaches rather than excessive analytical effort. World hunger and the churches give another example of the fallacy in the past of exclusive devotion to short-range solutions - ministering to need rather than enabling those in need to help themselves - giving one a fish versus teaching one to fish. The leaders in every village in the world should work toward local solutions to the global hunger problem. We in the west cannot be everybody's daddy, but we can always be on call with resources - particularly enabling leadership - to help others help themselves.

CONCLUSION

Since higher education is in the business of training professionals, it might be a worthwhile UME project to enlarge the code of ethics of the professional to include a commitment to the long-range service to his client, even while involving financial sacrifice to the professional. The global and future perspectives are much needed, but a new local perspective will be an important part of a holistic approach to experts helping and communicating with the citizen to make him more responsible.