



A Blessed and Joyous Eastertide!

As the Church reels from allegations of priestly pedophilia and Episcopal cover-up, especially in the United States, the rest of our opportunities and problems remain. Scientists are still working in their laboratories and their products, as interpreted by press and pundit, are still raising issues for the Church on several interlocking levels such as cloning and research on embryonic stem cells. What do these issues and many others mean for the future of the Church?

With that in mind we decided in this issue to reprint the Fifth Chapter from the ITEST book, *The Vineyard: Scientists in the Church*. In our view the apostolate of "like on like" of Vatican II is absolutely fundamental to true faith/science work in the Church. The very existence of such an apostolate in the Church depends on a deepening understanding of the Faith on the part of scientists and technologists. But that is only the beginning of the mission of the scientist and technologist in the Church.

There is also what we might call the time-dimension of Christian doctrine. Here we are obviously talking about the development of doctrine. The whole question of the Development of Doctrine was treated in an essay by Cardinal Newman. In his sense, it is our task always to refer any advance in science and technology to the growing deposit of faith. Our faith grows as scientific discovery lead us to re-interpret some aspects of reality. Maybe we can call it revelation without a capital. But the re-interpretation must come from doctrine for its ultimate meaning for the faith. This is what is referred to in theology as the *sense of the faithful*. Anyway, please read and meditate on the chapter reprinted in this issue of the Bulletin.

In the meantime, have a blessed Easter. The bodily Resurrection/Ascension of Christ is the very basis of our faith. May God continue to give you his best gifts. Please remember our Vice-Director, Dr. Robert Bertram, in your prayers. He has an inoperable tumor in the brain that has not responded to treatment. People like Bob are impossible to replace. He is truly one of God's chosen ones. Let us pray also for his wife Thelda -- that she have the strength to continue to support Bob.

*Robert Brungs, S.J.*

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## ANNOUNCEMENTS

**CHANGE OF ADDRESS:** We are changing our mailing address to *3601 Lindell Blvd., St. Louis, Missouri 63108*. This eliminates the middle step of the mail traveling through the St. Louis University mail system before it reaches us. Although you may still reach us at 221 N. Grand Blvd., St. Louis, MO 63103, we will adopt the Lindell location as our standard address. Since the ITEST offices are located in this building (Jesuit Hall), it seems logical to have our mail routed here.

2. **UPDATE:** September 27-29, 2002 workshop: *Advances in Neuroscience: Implications for Christian Faith*. Invitations containing registration information on this weekend will be mailed to ITEST members soon. If you would like us to send an invitation to colleagues, associates or friends, please apprise us of their addresses and we will be glad to send them an invitation. Or, if you prefer, we can send you more copies.

In the previous Bulletin we listed the essayists and their current professional backgrounds. The authors and titles of their essays follow: Dr. Amalia Issa - *Emerging Moral Questions for 21st Century Neuroscience*; Dr. Keith Crutcher - *Functional Brain Imaging: Is there a 'God-Spot' in the brain*; Dr. Carla Mae Streeter, OP - *Organism, Psyche, Spirit - Some Clarifications: Toward an Anthropological Framework for Working with the Neuro-Psycho Sciences*; Dr. Michael Wyss, *Emerging Neurobiology of Memory and Decision Making: does neurochemistry free us of personal responsibility?*

We urge you to register as early as possible to guarantee a place at the Workshop. Space is limited to approximately 50 participants.

3. **CREDIT CARD INFORMATION:** We are actively investigating the procedures necessary to establish ITEST as a "merchant" for ITEST members who have requested the availability of paying dues with credit cards. Overseas members have repeatedly asked us to look into the credit card method because it would be much less expensive than cutting a check or obtaining a money order. In plain words: If, at the June meeting, the ITEST Board approves our becoming "merchants," then we will set the process in motion so that members will be able to pay dues or purchase ITEST books and materials using their Master and/or Visa cards. The percentage on each transaction is currently 2.5%, which ITEST will pay to the sponsoring bank without the membership being charged for this service. Note carefully the announcement section of the Summer *Bulletin* for the outcome and more specific information.

4. **REMINDER:** We invite our readers (and writers) to submit articles for publication in the Bulletin. We have a large and widespread circulation reaching into South and Central America, Canada, Europe, Africa, Oceania and

Asia. We may be spread thin in some countries, but our presence, represented by our ITEST members and publications, is a positive force for our ministry. As you already know that ministry examines advances in science/technology from the perspective of the Christian Faith. Your article can contribute to the understanding of our mission; it can also serve as a motivation to further creative thinking and problem solving in the faith/science area.

5. **FEATURED ARTICLE:** Note carefully the article featured in this issue of the bulletin: *The Task of Christians in Science*. The staff chose this because it was a timely chapter of a book (*The Vineyard: Scientists in the Church*) written in 1992; it continues to be timely 10 years later. If anything, the message has an added thrust and urgency in the 21st century. With claims of "miraculous" advances in science/technology trumpeted widely and loudly in the print and electronic media respectively, it is perhaps more important today that ITEST members probe carefully our attitudes toward engaging colleagues, friends and, yes, even the "unfriendly" to examine these advances in sci/tech in the light of Christian Faith.

The co-authors of this book, from which this article is drawn, see the need to remind readers that one of the "tasks" of a Christian, whether artist or artisan, is to grow in love with Christ, to be Christ to others and in so doing we can "...bring the wonder, the beauty and the joy of our faith to our colleagues." What better way to engage our colleagues in this appreciation of the glories of God evidenced in science/technology than by inviting them to join us in our ministry, ITEST. The authors continue, "(thus)...we help our science and we help the community in which we cling to God."

This year we could each make an Easter resolution to recruit one person for ITEST membership. Recently, we renewed our baptismal vows during the Easter Vigil services. Perhaps what we voiced aloud will find a silent echo in our hearts and minds. Our covenant with Christ bears fruit as we share with others the grace-filled calling to bring Christ more fully into this world. If this sounds a bit "preachy" please put up with it and with the staff. These are things which we perceive should be said. This is a corporate ministry and the staff is merely that, namely, the staff. Our whole task is to provide each of you with the works of all the members.



## THE TASK OF CHRISTIANS IN SCIENCE

Dr. Eva Maria Amrhein  
Fr. Robert A. Brungs, SJ

*[This is the final chapter from the out-of-print volume, The Vineyard: Scientists in the Church, published by the ITEST Faith/Science Press in 1992. Some things are worth saying again -- after ten years. Dr. Amrhein has her PhD in Solid State physics and worked for some time in the United States on non-crystalline solids, microwaves and sub-mm spectroscopy. At present Dr. Amrhein resides in Germany and is in the administration of her institute, the Schoenstatt Sisters. Fr. Robert Brungs, SJ, also a solid-state physicist, is the Director of ITEST.]*

Science ... is an extraordinarily successful way to study quantitative phenomena. Despite all the power of the scientific method, despite the undeniable success of the method, there is nothing in the method that determines the direction of science. Science is always wide open to the designs and desires of outside forces and pressures.

As Herbert Butterfield stated:

The passion to extend the scientific method to every branch of thought was at least equalled by the passion to make science serve the cause of industry and agriculture and it was accompanied by a sort of technological fervour. . . . It has become a debatable question how far the direction of scientific interest was itself affected by technical needs or preoccupations in regard to shipbuilding and other industries; but the Royal Society followed Galileo in concerning itself, for example, with the important question of the mode of developing longitude at sea....

Indeed the scientific and the agrarian revolutions form such a system of complex and interrelated changes, that in the lack of a microscopic examination we have to heap them all together as aspects of a general movement, which by the last quarter of the seventeenth century was palpably changing the face of the earth....<sup>1</sup>

Cannot we add a Christian element to the direction in which science goes? We should certainly be working to develop an input all along the line, from the individual scientist in the laboratory to the halls of the National Science Foundation, the National Institutes of Health and the National Academy of Science and government agencies wherever we are. We (the authors) know that it is anything but popular to speak of our Christian responsibility to carry the Good News to the ends of the earth, least of all to be the bearers of the Word in the scientific community. But where in our society is there a deeper need of Christ's spirit than in the field of scientific development?

We cannot let the entire direction of scientific advance rest

in the hands of those who either are antithetical to the Church or are massively indifferent. We believe that without *being triumphal* we can move to claim the inheritance that belongs to the children of God. We have no reason to be as defensive as we have been vis-a-vis the scientific community. We have a right and a duty as Christians to do what we can to direct the advance of science in ways that will directly contribute to the final Kingdom of the Father. Understanding what this implies is something we have to work on seriously as well -- and quickly.

### THE TASK OF CHRISTIANS IN SCIENCE

Like all Christians, scientists and technologists are called to continue Christ's mission of salvation, to carry God's saving message in Christ to all the creation. As Vatican II has stated:

Christ's redemptive work, while of itself directed toward the salvation of men, involves also the renewal of the whole temporal order. Hence the mission of the Church is not only to bring to men the message and grace of Christ, but also to penetrate and perfect the temporal sphere with the spirit of the gospel. In fulfilling this mission of the Church, the laity, therefore, exercise their apostolate both in the Church and in the world, in both the spiritual and the temporal orders. These realms, although distinct, are so connected in the one plan of God that He Himself intends in Christ to appropriate the whole universe into a new creation, initially here on earth, fully on the last day. In both orders, the layman, being simultaneously a believer and a citizen, should be constantly led by the same Christian conscience.<sup>2</sup>

This mission of all Christians is specified a bit later by the Council:

The apostolate of the social milieu, that is, the effort to infuse a Christian spirit into the mentality, customs, laws, and structures of the community in which a person lives, is so much the duty and responsibility of the laity that it can never be proper-



ly performed by others. In this area the laity can exercise the apostolate of like toward like. It is here that laymen add to the testimony of life the testimony of their speech; it is here in the arena of their labor, profession, studies, residence, leisure, and companionship that laymen have a special opportunity to help their brothers.<sup>3</sup>

This evangelization of "like by like" is a significant element of the mission of Christian men and women in science. The scientific and technological communities cannot be the only neighborhoods in the city of the world in which we have no evangelists. These communities must hear the Good News from the inside, as it were, from their own colleagues who are just as committed to the canons of science as they are, but who are also dedicated to their faith in the Lord Jesus. While no one can give detailed rules on how this is to be accomplished, it can be noted (and emphasized), that we are talking about evangelizing, not proselytizing. By evangelizing we mean witnessing in our lives to the Good News of God-made-man. Immediately prior to his ascension into heaven, Jesus said to his apostles:

It is not for you to know times or dates that the Father has decided by his own authority, but you will receive power when the Holy Spirit comes on you, and then you will be my witnesses not only in Jerusalem but throughout Judaea and Samaria, and indeed to the ends of the earth (Acts 1: 7-8).

Our world is the community of science and technology in which we live and work and to which we bring Christ.

This is an area where much of the mode of spreading the Good News might have to be left to the experience of those doing it, to their own personal manner of dealing with those with whom they work and recreate, to their own communication skills and to their own vision of both science and faith. While each one of us has something different to bring to this mission, in our background, talent and opportunity, it is important to work at the evangelization of the scientific/technical community in concert with the hierarchy and with each other insofar as this is possible. In other words, some of us may have to work the very specific modalities for ourselves because of our own circumstances. We must, however, overcome the temptation to flee to the I-don't-know-how-to-do-this syndrome to escape *any* responsibility for evangelizing this community. We should also seek to coordinate our efforts with other Christians in our community.

It would certainly help to talk this over with other Christians in our school or work place -- if we can find any. It is clear that there often is a problem in even knowing which of our co-workers is a Christian. One physicist pre-

sently at a major Catholic university tells the story of finding out that four of his colleagues at Oak Ridge, Tennessee were Catholics only when, while at a conference, they all showed up in the neighboring church for Mass on Sunday. By and large, Catholics do not tell their pastors that they are scientists and they do not tell their colleagues that they are Catholics. This type of anonymity makes any kind of a coordinated mission extraordinarily difficult. Certainly a first step would be introducing like-minded Christian friends and colleagues to the faith/science groups with which we are familiar. This is, perhaps the easiest of the apostolic tasks we have before us. Yet, as in any endeavor, there is strength in a common vision, a common goal and pooled effort. There is strength as well in numbers.

In general, the parish has not proved itself to be an effective base for grounding this kind of lay mission. The parish may be too small and too anonymous a unit for a serious coordination of such effort, except in unusual situations like Oak Ridge, Tennessee or Los Alamos, New Mexico. Dioceses, where much could be accomplished, have by and large done very little to encourage or enable Catholics in science and technology to pursue their evangelical mission in the scientific and technical communities. Perhaps we shouldn't even look to them to do so. Generally, but not universally, priests and bishops are unfamiliar with science and with advances in technology. Even more discouraging is the fact that many of them do not appear to care to learn. We believe that, pragmatically, this uninformed apathy can be put to good advantage in that it will allow a great deal of freedom for the laity to cope with these issues that fall within their competence.

But if neither the parish nor the diocese offers a sound base for this apostolic work where can we look for such a base? To the Catholic colleges and universities? Unfortunately not, except in a few rare cases! In many ways Christian colleges and universities, with all their resources, seem to be less aware of and less open to this kind of work than the parishes and dioceses. In this regard we are most critical of Catholic colleges and universities, not because they are necessarily worse, but because they are the ones we know best. This may seem incredible at first blush, but the experience of one of the present authors (Brungs) over many years confirms it. Is there nothing that can be done, then? On the contrary, there is much to be done and much that can and will be done.

It is difficult to talk in general terms about the commitment of church-related schools to faith/science issues simply because it is very difficult to talk in general about the commitment of these schools to the Christian faith tradition out of which they rose. Beyond doubt, there is no univocal understanding of the colleges' and universities' role vis-a-vis their church-relatedness. The first task for Christians who teach science and do research in church-related



schools, it would seem, is to bring to the fore in their institutions the whole question of their institution's dedication to its faith tradition. Although each institutional situation will be different, we can at least call for an explicit statement of corporate goals. Again, although each institution is different, this effort at explicitation almost certainly will require more than one person's effort.

Simply on a practical level, we might suggest that any science faculty member who is serious about his or her Christian mission might recruit as many other faculty members who are interested to begin an informal seminar-type meeting with interested students. That perhaps might later be expanded into a more formal classroom program. May we suggest that any of the books listed in Appendix 5 might be used for such a program? Also, if fiction would serve the purpose, C. S. Lewis' space trilogy (*Out of the Silent Planet, Perelandra, That Hideous Strength*) would be useful for discussion. Also, ITEST (See Endnote 1 in Chapter 1 for a description thereof) is about to embark on the creation of material for such meetings and, we hope to prepare a text book which could also be used for an accredited correspondence course for those who desire or need the academic credits.<sup>4</sup> This material will emphasize the doctrinal aspects of the Christian faith with a special stress on matters relating to faith/science issues. If the informal meetings are successful, they might possibly be expanded first into departmental offerings and perhaps into broader interdisciplinary settings. If successful, they could be used to broaden the discussion of a school's corporate response to its faith commitment.

As we envision it, the integration required in such a program is not some methodological unity nor a rationalistic integration. It flows rather from a realization that there cannot be a conflict between a belief in the *ex nihilo* creation in Christ and the world so created in Christ. As we indicated earlier, this is not a drawing closer together of a science (more exactly, a philosophy of science) and a theology. It relies on the very basic understanding that Christianity is not a cosmological religion (based on some necessary rationalism) but a historical religion (founded upon the sacrificial life, death, resurrection and continued sacramental, Eucharistic presence of Christ in creation).

In brief, any successful faith/science program must rely on a commitment to Christ in a world created in and for him. It must be a lived program, not merely one dedicated to a more or less exotic intellectual approach. A program like this is not likely in many church-related colleges and universities. It requires too high a Christian profile for many of them, especially for the larger college and university milieu. We believe it is apparent that this kind of "basic evangelization" inside our own church-related institutions really requires what the second Vatican Council called the "group apostolate." It would be a very rare campus where

a single faculty member could initiate such changes in institutional approach. Also we would stress again the value of contact with groups that have members on many campuses for a further exchange of ideas and support.

In the broader world there is good reason to take great hope from those lay movements that have sprung up within the church during the last decades to extend or complement already established pastoral activities and other institutions, founded by the initiative of individual priests and lay men and women in response to a special apostolic calling.<sup>5</sup> Scientists, however, are rare among these innovators. Can anything be done about it? Certainly the church needs such committed innovation, so God will provide the apostles — that is, us.

Vatican II reminds us:

The individual apostolate has an area of special opportunity wherever Catholics are few in number and widely dispersed. Here the laity who engage in the apostolate only as individuals, whether for the reasons already mentioned or for special reasons including those deriving from their own professional activity, can still usefully gather into small discussion groups lacking the more formal kind of establishment or organization. In this way an indication of the community of the Church can always be apparent to others as a true witness of love. Moreover, by giving spiritual help to one another through friendship and the sharing of experiences, they gain strength to overcome the disadvantages of an excessively isolated life and activity, and to make their apostolate more productive.<sup>6</sup>

The circumstances mentioned above can actually a blessing in disguise, we believe. There is something of a positive challenge in building an apostolate from the ground up. First, there will be correspondingly fewer fixed ideas on how this lay mission should be effected. Most Church leaders, it would seem, would be glad simply to know that something is being done. There is the rare opportunity here for the laity to develop the whole apostolate. This is a quite pragmatic set of observations, but they should not be ignored in favor of a merely idealistic approach.

It would be pleasant to think that church leaders and scientific leaders are breathlessly waiting for us to do something in this area. They're not! Most have never even thought about something like the lay evangelization of the scientific and technical communities. In a way we're not even ready to start laying the foundations for such an apostolic effort. We still have to clear the ground. We must first cope with the weeds that have grown from the Enlightenment myth of the objective scientist, with motives pure and shining, searching for the truth and leading man-



kind up from the miasmal swamps of mal-education, religion and superstition. We have to refute by our lives and our scientific skill the notion that scientific integrity is incompatible with religious belief.

We also have to cope with a Catholic intellectual leadership that has spent centuries refusing to assimilate to Catholic understanding the great advances in scientific learning. A modest beginning might be encouraging priests to become interested in the moral and doctrinal issues raised by contemporary science. At a minimum, seminarians should be encouraged to learn something about science and the history and philosophy of science. If we can get this kind of process initiated, we might eventually reach the point where specific courses in science would be available to them.

Offering such courses to seminary deans and/or the Bishop might encourage this kind of development. As we have noted, there are as many creative and imaginative ways to carry on this apostolate in the churches as there are dedicated Christians who see the need and importance of such evangelization. This might help in the future to prepare priests to discuss such issues from the pulpit with some assurance. We could also join together to prepare sermon material on faith/science issues. This could be done by one or two people at the parish or diocesan level or by many of us working together at the national or international level. Also, could we not think of letting our scientists (yes, the laity) preach from time to time what is happening in science and what it might mean for Christian living? This really is not that radical a notion.

As we have stated, many of the larger and more prestigious Catholic institutions of higher education have downgraded or eliminated graduate science programs, particularly, they say, because of the greater expense involved. The religious orders and congregations that once staffed most of those institutions have practically ceased sending their members into scientific areas of studies. Most of the Christians in science will come from the state or secular schools in the future. This has been the more normal situation in Europe for a long time. Nonetheless, with rare exceptions, the campus ministry programs in these institutions are not geared to promote a Catholic lay apostolate in scientific and technical arenas. It seems incumbent on the laity already active in these communities to work to bring to future scientists and technologists their obligations in the apostolate. It is clear, we believe, that a certain amount of *networking* (if you'll pardon the buzz word) is necessary for this crucial apostolate to assume any real importance either in the church or in the scientific and technical communities.

The faithful are called upon to engage in the apostolate as individuals in the varying circumstances of their life. They should remember, nevertheless,

that man is naturally social and that it has pleased God to unite those who believe in Christ in the People of God (cf. 1 Pet. 2: 5-10) and into one body (cf. 1 Cor. 12: 12). Hence the group apostolate of Christian believers happily corresponds to a human and Christian need and at the same time signifies the communion and unity of the Church in Christ, who said, "where two or three are gathered together for my sake, there am I in the midst of them" (Mt. 18: 20).

For this reason the faithful should exercise their apostolate by way of united effort. Let them be apostles both in their family communities and in their parishes and dioceses, which themselves express the community nature of the apostolate, as well as in voluntary groups which they decide to join.

The group apostolate is highly important also because the apostolate must often be implemented through joint action, in both the church communities and various other spheres. For the associations established to carry on the apostolate in common sustain their members, form them for the apostolate, and rightly organize and regulate their apostolic work so that much better results can be expected than if each member were to act on his (or her) own.<sup>7</sup>

As we said earlier, a program like this is not likely in many church-related colleges and universities. At the present time it sometimes seem more feasible to work *from the outside* with students in scientific and technological areas on secular campuses. This kind of activity is needed as much as that on the church-related campuses. Already established Christians scientists on the faculty of private and state universities, with the help of other Christian faculty members and the campus ministry programs, ought to take the initiative to familiarize their students on the need for scientists to be active in the churches and to remind these students of their baptismal responsibilities in the "apostolate of like on like." This is not simply a romantic dream. We are told that in places where the campus chaplains are concerned about the students in the sciences (e. g., The University of Kansas), there is a great deal of interest among the students for these initiatives. We are including a brief description of the Kansas program in Appendix 2.

Clearly, Christians in science on secular campuses and in industry cannot usually expect or effect campus-wide programs in faith/science issues. Nonetheless, there is a dire need for informal programs of study, dialogue and cooperation to be established throughout the scientific world. Many, many scientists have told us that, if it is discovered



that they are Christians, their scientific credibility is called into question. The first task of all of us is the destruction of such a negative view of faith and of such a narrow appreciation of science and its role in the glorification of the universe. Then, we can actually enter into discussion on the more serious value of Christianity to science and vice versa. At present, we are not ready even to build a foundation for a vital Christian presence in science, but we can certainly begin to clear the ground of the debris of the last couple of centuries.

Clearly there are, as we mention elsewhere, occasions and situations where Christians in science or technology have to be very careful not to reveal their Christianity. They may be rare, but there is no doubt that they exist. In this regard, Robert Bertram<sup>8</sup> has remarked:

My second point comes by way of a quotation from a little known theologian, who deserves to be more widely known. He is a Rumanian Orthodox theologian by the name of Petru Demetriu. His book, in its English translation entitled *Incognito*, would not be a bad book to read to explore what Father Brungs referred to as anonymity. Demetriu endorses a kind of Christian incognito, a deliberate anonymity — that's not what Bob Brungs is talking about — as Christians move out into the secular sector, not beginning at least by dropping the name, but perhaps, as apostles and evangelists, cultivating the curiosity of their scientific colleagues who are not Christians or who are lapsed or weak Christians, perhaps more by their performance than by their evangelization assertions.

#### OUR LIVES IN CHRIST

Having said all this about the needs and opportunities for direct work with others in the scientific and technical areas, it is particularly important to note that this is a second step in a Catholic scientist's evangelical life. The first step, which we should consider here, is ontologically and doctrinally the most important. We have spent a great deal of time stressing the radical reality of our union with Christ which arises out of our baptism and is strengthened in our sacramental life (always and especially the Eucharist) and our prayer. As Father Kentenich said in 1928:

With our love for God we have to kindle our love of neighbor. If I am cold, I cannot kindle the fire of divine love in others. Here we touch the core and the most difficult problem of the apostolic movement. Nowadays we could recruit many people in the lay apostolate to perform exterior apostolic deeds. But how the people discern and reject the motives for this action! This might be a natural compassion; this might be the natural drive for

activity. Not in the least will it be the drive for recognition: to be appreciated by the leader or the pastor. There is nothing wrong with such motives playing along. But, according to the essence of the apostolate, this does not hit the nail on the head. This would be building on sand. . . Speaking about Catholic Action we may not be mistaken: the soul of the apostolate is and remains the inner union with God. This is essential.<sup>9</sup>

If we are in union with Christ he accompanies us into the laboratory or the classroom. We *all* have to remind ourselves of this from time to time because it is not apparent except with the eyes of faith. Nonetheless, Christ literally is present to the scientific world *in us*. Not only do we have to *remind* ourselves of this, we have to make a conscious effort each day to let this truth become visible in our attitude and deeds. Our colleagues (our fellow citizens?) do not have the eyes of faith to recognize Christ's sacramental presence in us. Unless this presence shows in our actions, in our way of being, Christ may not touch them. Genuine apostolate, as our modern pluralistic society requires it, is first of all *cooperation* with the grace of our union with Christ by a serious effort to become saints in action.

Vatican II (cf Laity no. 13, p. 504 above) calls it the "testimony of life" by which the laity transforms the world into Christ. In other words: the only gospel people read today is the life of the Christians. As mentioned before, the root of the problem of interfacing faith and science is not that there are no Christians within the scientific and technological communities but that they do not influence their surroundings sufficiently. They cannot do so, and Christ cannot do it in them, if their religious formation (we mean: character formation, not intellectual knowledge alone) stays at the level of first communion instructions. Our ontological union with Christ has to mature into a unity of thinking, loving, and living.

We mentioned in Chapter 4 what this implies: Christ's own attitude has to become ours. His inner orientation to the Father's will has to direct our decisions. His responsibility for "my Father's business," i.e., the unfolding of all of creation, must animate our work. His love for the Father and the Father's kingdom should become our love and hope carrying out our scientific endeavor. It is in the person of the individual Christian scientist that faith has to penetrate science and Christian love to direct its advance.

If, in this way, we are in vital union with Christ, we are literally worshipping God in our scientific activity. For those living a life of grace, every human action which is in accordance with the will of God is an act of worship. We *can* and do worship God, in the fullest sense of the word, in our daily lives. Like any liturgy, however, this worship



needs our active participation, in our case the striving for sanctity in our everyday lives, a gifted duty incumbent on all Christians.

In union with Christ we are transforming the world with him in a special way in the scientific arena. In the labs, the classrooms and the boardrooms we are participating in Christ's bringing the being-redeemed world to the Father in a special way. We are, if you will, participating in the building of the New Jerusalem in a methodologically significant manner. *Christ is there in us!* We simply cannot say that too often! This truth must penetrate our lives and transform them.

We have been told that we are to imitate Christ. We are not so much called to imitate Christ as much as *become* him to our brothers and sisters and to our whole world. So it was with St. Paul (cf. Gal 2: 20) and any apostle. Such transformation into Christ is nothing else but the reality of our baptismal covenant taking shape in our lives. There is no set prescription for us in reaching this goal except for the commandment Christ has given us. The New Covenant is a gratuitous bond of friendship, of personal love, between Christ and us in the church. Grace and our response to the New Commandment, divine and human love, must work together in exercising what St. Augustine calls the "transforming and assimilating power of love." As far as our contribution is concerned, this means a serious effort to know our Covenant partner, Jesus Christ, to communicate with him, and to prove our love for him by deeds. The way we do this must be *personal*, i.e., unmistakably *ours*. It must be done insofar as is possible with others in the Church. Again, we are not divine freelancers. We must urge our brothers and sisters in the Church to become deeply involved in the evangelization of the scientific/technological community.

It has already been said in these pages that our Christian life in Christ is specific. All available evidence seems to indicate that we are to love and serve God in our singularities (particularities and even peculiarities). Ours is not an abstract call to some generalized way of doing things. We are not called to imitate in detail the lives of, say, Albert the Great or Thomas More. We should be moved to display our integrity before God as they displayed their integrity. Their zeal and love should inspire us to be zealous in love of God. But it is *our* life before God we are to display. In short we are *all* called to be saints — as ourselves. God does not demand the same thing of any two of us. Nor has he given the *same* gifts of heritage, talent, grace and opportunity to any two of us. The Schönstatt Movement<sup>10</sup>, for instance, encourages its members to reflect on that "Personal Ideal"<sup>11</sup> that God had in mind in creating this individual with his/her specific gifts according to the image of his Son, Jesus Christ.

Christ's fullness cannot shine forth in his church unless each one takes up one specific part of it. Our striving to *become him* receives a new vigor and decisiveness when we are aware of our very specific calling. This has consequence for our apostolic lives. As we grow in our union with Christ, as we grow more and more to represent him in our own personal world, the Holy Spirit takes greater possession of us and our activity. Judging from the individual and corporate history of the covenanted community, the Spirit continually pushes us toward the *outside*. As we've noted, the Spirit on Pentecost did not encourage the apostles to remain in the upper room in prayer, but rather impelled them into the streets to proclaim the message of Jesus Christ risen from the dead. So the Spirit impels us into the streets, in our case the laboratories and classrooms of the world. We, too, in our own way are to proclaim the resurrection of our Lord Jesus Christ. A Christian is an apostle by nature. Thus, in the carrying out of our baptismal obligations to preach Jesus, each of us has to find his or her own special way, commensurate with those gifts and graces and opportunities that have been given to us.

We are to meet God and spread his love in *our* communities, in *our* families, in *our* neighborhoods, in *our* labs or offices, and so on -- and to do this in *our* own ways. It has always been a teaching of the church that the primary way to do this is by example. We are not called to dominate another's life before God nor to preach the *only true way* to serve God. We are not called to demand obedience or loyalty from others. But we are sent by God to be, by our lives and example, an open invitation to all men and women to look to Christ.

So, what we mean in these pages by *evangelization* is not proselytizing; it is not sermonizing. It is inviting others to see Christ in our desires to pursue good science or to produce good computers or toasters. It is not so much telling people to go church as it is initially turning our colleagues' attention to the human dimensions and effects of our work in Christ. It is leading people to think beyond the experiment on the work bench to the effect that this experiment will have on individuals, on society and on the entire universe.

In short, our evangelical lives could and should be like Christ's treatment of James and John:

On the following day as John (the Baptist) stood there again with two of his disciples, Jesus passed, and John stared hard at him and said, "Look, there is the lamb of God". Hearing this, the two disciples followed Jesus. Jesus turned round, saw them following and said, "What do you want?" They answered, "Rabbi," - which means Teacher - "where do you live?" "Come and see" he replied; so they went and saw where he lived, and stayed with him



the rest of that day. It was about the tenth hour.  
(Jn 1: 35-39).

Does the way we do or teach science draw people to wonder "where we live"? Does the way we conduct ourselves in all the aspects of life lead to that kind of questioning? There is no magic formula for this, but if we grow in Christ he will show us how to be an invitation for others. The important thing is that we serve God in our scientific endeavors and in our family lives as well as in the Church. We build up the Church in our scientific and familial lives as well as in the Church. These aspects of our lives are not separate; being a Christian is not a schizophrenic approach to living; it should bring a true unity to all the aspects of our lives.

If we live our life with Christ we can bring something to science which it seems to have lost in the last couple of decades. We would seriously ask if whether a part of science has become the quest of a grant or a patent. Has the "publish or perish" part of science come about at the expense of curiosity/wonder and eventually awe? Realistically, how much science is done because research or teaching is a good job and provides a good living rather than out of a sense of wonder at the simple complexity of the physical world? We all know that there is a blend of motivation among scientists and even within a single scientist. Very few of us, as we have already noted, act out of pure motives. Usually our motivations are as complex and mixed as we are.

Is science more of a business than it used to be? Perhaps, if we bring Christ to the laboratory in a more self-conscious way could we begin to effect a change in the way science itself is done? Could our example of wondering at the beauty of physical systems be an antidote over time for the fraudulence that has crept into it? It certainly should be. Science should flourish in an atmosphere of humble awe before the mysteries its method and work reveal. The arrogance of fraud and of prestige-hunting should never be a part of it. We can, if we really come to *be Christ* for our part of the world, bring back the humility and awe that are so conspicuously absent from at least some of contemporary science.

#### SCIENCE AND THE DEVELOPMENT OF DOCTRINE

There is another whole area of the apostolate of science that we have yet to mention and which is as important for the future of the Kingdom of God as being evangelists to the scientific world. It has been mentioned before that Christianity is an earthy and earthly religion insofar as its God has become a human being and, upon ascending to heaven, *remained* a human being. That has a very definite further implication for the Christian man and woman in science.

In the course of the last three centuries science has given us a much greater awareness of both our greatness and our smallness. Three thousand years ago the Psalmist, looking up to the heavens proclaimed:

The heavens declare the glory of God,  
the vault of heaven proclaims his handiwork;  
day discourses of it to day,  
night to night hands on the knowledge.

No utterance at all, no speech,  
no sound that anyone can hear;  
yet their voice goes out through all the earth,  
and their message to the ends of the world.

High above, he pitched a tent for the sun,  
who comes out of his pavilion like a bridegroom,  
exulting like a hero to run his race.

He has his rising on the edge of heaven,  
the end of his course is its furthest edge,  
and nothing can escape his heat. (Psalm 19: 1-6)

Today, we can see far beyond the ability of the Psalmist. With the invention of the telescope in all its forms we have expanded our sensorium beyond anything that could have been imagined even four hundred years ago. But even with our expanded sight and our discovery of galaxies, pulsars and quasars and things we can't name or understand we have not poured out such praise of their Maker as did the Psalmist. Our physical vision has expanded by many orders of magnitude, but our praise has not. This is only one area where science has provided us with an awareness of both the delicacy and awesomeness of physical systems.

As the Psalmist could look out and see the macro-world, we can now, with our array of microscopes, behold a micro-world just as beautiful as the heavens. It is as complex a world with a delicacy of structure that we do not observe in the heavens. Yet, even with this much greater ability to see the handiwork of God that was hidden to the Psalmist, we have not surpassed the ancients in our praise of the Creator.

We now know, for instance, that all living systems are unified at the level of the amino acids. The same components of DNA build mosquitoes and academic deans or neuroscientists. But our praise of the Creator has not grown either in its quantity or quality. We are well aware now — another gift of the life scientists — that women as well as men contribute to the genetic makeup of their children. Yet, even after some hundreds of years, not all of our theology has sufficiently incorporated that rather basic notion.

Often enough the guardians of the Christian patrimony (bishops and theologians) have reacted to scientific advance



with opposition. Even that was better, however, than the indifference we now encounter, especially in the case of contemporary theologians. In the event of opposition, the truth will finally prevail. Advances which seemingly conflict with Christian teaching and belief *should* be examined and our *theology* questioned. But we can't come back from indifference. Whatever else they may be, the clergy is largely ignorant of science and technology. The same, however, holds true for the occupant of many a chair of humanities studies. This, of course, does not disqualify them from membership in the human race. If it did the planet would practically be uninhabited. It does, however, harm the Church and limit the praise due to God. It stifles both the poetic and theological imagination of the church. In short, it inhibits any real growth in our appreciation of the creation God has given us.

In a certain sense, we could call the historical influence that science has had on our self-understanding a kind of demythologizing, a becoming aware of both our limits and our interconnectedness with the rest of creation. We have learned from Copernicus, Galileo and Newton that the heavens and the earth follow the same physical laws, that there is a physical unity throughout the universe. We have learned from Darwin that there is a unity of all living systems at the level of the species. The work with recombinant DNA, as we said earlier, has deepened our understanding of the unity of all living systems at the level of the amino acids, the basic building blocks of those systems according to our present understanding.

While the scientific understanding of the past few centuries has diminished our stature as being at the physical center of the universe and being a species totally set apart from the other species, still it has enhanced our dignity as the world to which Christ came and as the species into which he became incarnate. We know from revelation that our world is the center of the created universe in the order of salvation and the order of the final Kingdom of God. We know also that the human species is the one which God chose to enter physically. We know that in Christ we can master our drives and finally become integral and integrated persons — Freud notwithstanding. Science has displaced our ideas that we are at the physical center of things; revelation has disclosed that in the new creation in Christ we are at the center of God's will for creation.

Unfortunately, little of this information has penetrated into the consciousness or work of the ecclesial/theological community. Worse, since those now teaching the next generation of theologians are not aware of these major new understandings of physical creation, we can expect little help from those now being trained — unless this can be reversed. Who will trigger this reversal? Who can do this except the Catholics in science and technology? This, then, is an extremely important, nay urgent, part of the life of scien-

tists in the church — to be catalysts for this major development of doctrine.

This will not be an easy task. First, we must guard against a too facile movement from the empirical to the theological. The primary data of Christian doctrine is revelation, not science nor philosophy. We cannot, for instance, automatically assume that entropy is a consequence of original sin -- as has been done. (Strangely enough, the person who made that equation would not accept the redemption as anti-entropic.) But the best scientific information we can gather at any given time can play a major role in our understanding of revelation. This appropriation of the best of contemporary information and view of the world has been done throughout the whole history of the church. It has its warrant from the very highest authorities in the church -- both hierarchic and intellectual authority. Pope Leo XIII in his encyclical *Providentissimus Deus*, which in part dealt with the then current state of the controversy over evolution, quoted with approval St. Augustine's remark: "When they (here, scientists, etc.) are able from reliable evidence to prove some fact of physical science, we shall show that it is not contrary to our Scripture."<sup>12</sup>

The Greek Fathers of the church began early to appropriate Greek poetry, philosophy and piety to the service of preaching the Good News. For instance, Greek thought about the sun and moon (*Helios* and *Selene*) was used to establish and date the feast of Christmas. The Fathers also assimilated the Homeric mention of *moly* (a plant given by Apollo to Odysseus to help him resist the blandishments of Circe) to explain the theology of the Logos. Examples of this kind of appropriation and assimilation abound throughout the theology of the Fathers. Hugo Rahner in his classical study of this movement in the early church, *Greek Myths and Christian Mystery*, writes:

But the concluding chapter in this story of Christianity's ultimate settlement with paganism, the chapter that is laid in Rome, follows much the same pattern as that which we have already studied. The Church opposes, the Church dethrones, the Church consecrates, and in the end the Church brings home.<sup>13</sup>

It is time for the church to *bring home* the solid advances in science. We who are dedicated both to our faith and to our science are truly the ones who can best accomplish this at present. We must do it as a group, however loosely organized. In numbers we have the greater strength and the greater wisdom needed to *begin* this task of developing the church's doctrinal development. In time, we must bring solid development to the attention of those whose task it is to verbalize this information in a competent theological treatment. Organizations of scientists and theologians like the Institute for Theological Encounter with Science and



Technology (ITEST) can be of great value to the church in the process of translating scientific achievements into ecclesial vocabulary and theological development.

Technology presents a different, though not unrelated, set of problems and opportunities to the church. In many parts of the world, especially in the most highly technological countries, there are voices crying out about the dangers of the dehumanization of people by technology. The anti-technological movement ranges from a kind of neo-Luddism to a realistic desire to understand and to direct the impact of technology on human beings and on the environment.

A reading of Genesis 2: 17 seems to indicate that God had foreseen the crises that humans run into as they unfold their potential in carrying out God's mandate "to subdue and conquer the world." In Eden, God told Adam and Eve: "Nevertheless of the tree of the knowledge of good and evil you are not to eat. for on the day you eat of it you shall most surely die." This tree of the knowledge of good and evil is, most likely, the power of deciding for oneself what is good and evil. It is a claim to moral independence of God on the part of the creature, not simply a search for knowledge. Many feel that this is a tendency in contemporary science and technology.

The Tower of Babel is another instructive story along the same vein. This is not only a story of learning to do things technologically. It is also a story of proclaiming moral independence in our use of both created nature and of our human technological genius and its power. C. S. Lewis in numerous places remarks that the human victory over nature is really a human's victory over other human beings using nature as a vehicle. There is certainly a great deal of expression of moral independence in our use of the products of our skill. There is a great deal of moral arbitrariness in how we proceed with our technological progress. As we grow more powerful technologically, the moral stakes become higher. It was easier, for example, for the church to accept a just-war theory when the effective range of death-dealing weapons was a few hundred feet. It is correspondingly more difficult when that range is several thousand miles with weapons capable of completely destroying large cities. The greater our power becomes, the more essential is its linking to goodness and, ultimately, to Goodness.

St. Thomas Aquinas (as quoted by J. Bernhart)<sup>14</sup> has phrased it thus:

God's power is his goodness. Therefore, he cannot use his power in a manner which is not good. With man it is not so. Therefore, it is not enough that man should resemble God in power, unless he resemble him in goodness (*Summa Theologiae* I-II, 2, 4 ad 1).

An inevitable consequence of this extension of human power and of human freedom is a continual raising of stakes. The basic human options become starker and more critical both individually and communally. People have devised methods of moving us through the air that can be used both to enhance human mobility, thus increasing human contact, and also to rain death from the skies. They have devised nuclear technologies that can provide power to our industrial centers and to our homes; but these same technologies can also be used to snuff out life on this fragile blue planet we call home. From year to year the stakes in this technological game called *Progress* are getting higher. Greater and greater *Progress* is matched step by step with greater destructive capability. It is not necessary here to list all the technological advances to show the double-faced aspect of the contemporary human technological challenge. Each of us instinctively feels the ambivalent character of these achievements. Equally instinctively, we feel the accelerating seriousness marking our technological choices.

We know that during the twentieth century science and technology have grown closer together and that many scientists, especially in electronics and biology, have become technological entrepreneurs. The lead time between scientific discovery and technological application has become much shorter. The obverse is also true. Technical breakthroughs more quickly propel new scientific investigations.

The Catholics in technology, of course, bear the same obligation *to be Christ* in their communities as do the scientists in theirs. There is, however, a somewhat different focus in their evangelical witness in the Church and in the technological and industrial communities. Since technology is by nature closer to application, closer to behavior and with more immediate effects on human beings and on the environment, technologists are more directly concerned with the moral dimensions than scientists. Although it is overly simplistic, we can say that, while scientists are more directly concerned with truth, technologists are more concerned with goodness. This distinction is by far too clean to be totally accurate, but it is indicative of the types of goals sought. Life rarely is quite so unambiguous and well-defined as this distinction would indicate. Nonetheless, the Catholic in technological areas will often be concerned with novel moral issues, concerns that will drive them and the Church back to first moral principles to develop legitimate ways of dealing with the new. This more frequent recourse to moral first principles is an aspect of religious life that is not as immediate to the lives of scientists.

Take, for example, the revolutionary advances in biotechnology. There is a tension between scientific social responsibility and making a profit. This tension has already arisen in an industry like the pharmaceutical industry where the cost of developing new products is usually quite high. This



is leading to some new problems for scientists in a field like molecular biology where perhaps a large number of researchers have corporate links. It is opening up a whole new set of issues in scientific ethics. An example is Walter Gilbert's plan to copyright the human DNA sequence. Gilbert, a biologist at Harvard with a new company called Genome Corporation, is quoted as saying that the sequence can be copyrighted because "somebody worked it out and wrote it down -- so the order of the letters is copyrightable, like a string of letters in a book." Other scientists are quite uneasy about copyrighting the sequence. The technologist faces this issue even more directly. (For this reason we would include health care providers more as *technologists* than as scientists.) How do we deal with these novel issues?

The Church will never cope successfully with these novel issues using only doctrinal conclusions from the past that have not been filled out with the valuable knowledge we have accumulated. Any successful approach to them is going to depend on a concomitant serious development of doctrine. We cannot put this new wine into old skins!

Perhaps it's not out of place to conclude by noting that this task of renewal in the Church will almost certainly have to be urged and developed by those of us in science and technology. Church "leaders" give no evidence of even being aware of the situation. They remind us of the "leader" in the French Revolution who was running down the street, trying to catch up with the crowd of his "followers" on their way to storm the Bastille. Our "intellectuals," even in Catholic colleges and universities, seem to be caught up in a non-historical rationalist search for truth that cannot admit that something real and novel is happening in science and technology. Moreover, even when the bishops do make a significant statement about science and technology, no one ever hears about it.

In 1977, the American Bishops at the Fifth Synod of Bishops made a significant intervention on science and technology. Have you ever heard of that intervention? I (Brungs) watched the Catholic press very carefully for three months after this intervention was made. To the best of my knowledge, this was printed in full only in *Origins* and alluded to in only one Catholic paper. What good is an intervention if it is never promulgated. I suspect -- I don't know this as a certainty -- that most bishops don't know that this intervention was made. We are including it in this volume as Appendix 3. It should be required reading for every Catholic scientist and technologist as well as every Catholic "intellectual leader."

Another example is the magnificent statement of Pope John Paul II contained as a preface to a recent book.<sup>15</sup> With permission of the authors, we are including it here as Appendix 4. It certainly has not become a widely dissemi-

nated exposition on the need for the church to meet the opportunities and challenges of contemporary scientific and technological advance. This is not said to fault either the Pope nor the authors of the book in which the message appeared. By and large, however, the Catholic communicators did not give it the attention it deserved. We do not believe that this was a deliberate attempt to undercut the Pope's message. It simply is beyond the purview and understanding of those who control the Church's channels of communication.

Thus, if we are waiting for the Church "leaders" to issue a ringing call to the scientifically expert laity to pool their talents and experience for the spread of the Gospel, we shall probably wait a long time. Unless there is a radical change, it is up to us, the Church's scientists and technologists, to undertake this task ourselves. Since, in doing it we are merely fulfilling our baptismal obligations, we need no one's permission.

If, however, we, the Church's scientists and technologists, are going to undertake the work of informing the Church of scientific and technical advance and evangelizing the scientific/technical community, we need a basic (faithful) understanding of the Church's teaching. We would never think of doing graduate work in science without a thorough understanding of the fundamental principles of the science. So, we should all learn the basic principles of the Church's faith in Christ present to the world in her. This is an important preliminary for any evangelization, as the Bishops mention in their intervention at the Fifth Synod in 1977:

In this connection, evangelization and catechesis by scientists who are men and women of faith are extremely important. They should be encouraged by the church. They constitute one of those small groups which will be responsible for so much of the mission of the church in the years to come. Scientists who acknowledge the reign of God should be encouraged to form communities where they may grow in their own understanding, experience and response to their Catholic faith, and where they show their insights into how the mysteries of redemption can be presented to their brothers and sisters who are seeking answers to the dilemmas posed by their scientific research.<sup>16</sup>

We are listing, in Appendix 5 a handful of books which will be helpful in beginning this preparation. These are not the only books available, but they would give their readers a good start in learning fundamental Christian principles. Also, ITEST is about to start preparation of a text book that will provide at least a beginning source for this. It is scheduled for publication in the summer of 1993.



## SUMMARY

We can never forget that Christ, in becoming and remaining one of us, has called us into the community covenanted in his body and blood. In baptism we are called to a share in the life of the Trinity in Christ. We live Christ's life, we think his thoughts, we share in his love for the creation he has redeemed. In baptism into Christ, assimilated into him in the Eucharist, we are called to be co-creators and co-redeemers of the universe. We bring to that task our own specific talents, background, experience and wisdom. Our task is to be Christ to the world in which we live and work, grow and love. It is a task specified for each of us by God's providential gifts, grace and love.

We who are scientists or technologists have a special gift to give the Lord. We can bring our training to the privilege of completing Christ's redemption of the cosmos. We can bring our curiosity and wonder and desire to discover the beauty and patterns of the world to the Church. We can help her understand the scope and the beauty and the meaning of the stupendous creation in which we live. We can alert her to the opportunities and the menace lying in the application of our knowledge. We can help her unfold further dimensions of the revelation we have been given. We can be instrumental in helping the Church further develop in truth her understanding of God's presence among us in Christ. If the next generations of Catholics are not able to understand their faith (and therefore live it) as the scientific world relates to it, we shall neither have done our duty nor fulfilled the vocation to which Christ has called us. It is *our* obligation, a gift God has given us freely to accept.

We can give to our colleagues in the scientific and technological communities an understanding of the beauty and the wonder of God's love. In our day and age we cannot always do this overtly but, as our love for Christ grows, we will discover more and more opportunities for *being him* and proclaiming him to our own world, our milieu. Clearly, in this evangelical effort, one person's ways will not be

another's. Yet bringing Christ to this world, working together with each other and with other organizations in the Church, letting others see in our lives our living union with God, we can bring the wonder, the beauty and the joy of our faith to our colleagues. In so doing, we help our science and help the community in which we cling to God.

## ENDNOTES

1. Herbert Butterfield, *The Origins of Modern Science*, New York: The Free Press, 1957, pp. 197-98.
2. Vatican II, *Decree on the Apostolate of the Laity*, no. 5, pp. 495-6.
3. Vatican II, *Ibid.*, no. 13, p. 504.
4. If you have any suggestions for such material, the ITEST staff would be delighted to hear from you.
5. *Spirituality of the Laity: Forms and Movements Today*. Documentation Service, Pontifical Council for the Laity, 8, 1981.
6. Vatican II, *Ibid.*, no. 17, p. 508.
7. Vatican II, *Ibid.*, no. 18, p. 508-9.
8. Robert Bertram, *Proceedings of the ITEST Conference on the Role of Men and Women in Science in the Mission of the Church*, [ITEST, October, 1983, pp. 20-21.
9. Joseph Kentenich, *Allgemeine Prinzipien der Apostolischen Bewegung von Schoenstatt*, Schoenstatt-Vallendar, Fed. Rep of Germany: mimeographed manuscript, pp. 87ff.
10. Jonathan Niehaus, *New Visions and Life, the Founding of Schoenstatt*, Milwaukee: Schoenstatt Fathers, 1986.
11. Josef Vermeegen, *The Personal Ideal and Particular Examination*, Waukesha, Wisconsin: Schoenstatt Sisters of Mary, mimeographed manuscript, ca. 1975.
12. Augustine, *De Genesi ad litteram 1*, 21, 41. The translation here is taken from John Hammond Taylor, S.J., *St. Augustine: The Literal Meaning of Genesis, Ancient Christian Writers*, 41; New York, N.Y./Ramsey, N.J.: Newman, 1982, p. 45.
13. Hugo Rahner, S. J., *Greek Myths and Christian Mystery*, New York: Harper and Row, Publishers, 1963, p. 146.
14. J. Bernhart, *Technik and Menschenseele*, 1955, p. 27.
15. Coyne, George V. et al, (eds.), *Physics, Philosophy, and Theology: A Common Quest for Understanding*, Vatican City State: Vatican Observatory, 1988, m1 - m14.
16. See Appendix 3.

## INCORRECT REASONING IN A BRIEF HISTORY OF TIME

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## ABSTRACT

The book *A Brief History of Time* (by Stephen Hawking) introduces the concept of "imaginary time," and then asserts

that time has neither a beginning nor an end, drawing the conclusion "What place, then, for a Creator?" In this paper,



that process of thinking (and of using words to express mathematics) is examined carefully. By paying very close attention to the temporal aspect of words such as "before" and "beginning," it is shown that there is a disconnect between the mathematical treatment of equations and the words on the page. The book contains a conflation between "imaginary time" - a totally spatial dimension - and "time". This undermines the argument leading to Hawking's conclusion.

## INTRODUCTION

In the popular book *A Brief History of Time* (Hawking 1988), there is a conceptual error, which makes an important conclusion incorrect. The error is not in the underlying mathematics or physics, but in the use of words to mean something different from what people think they mean. This essay examines that flawed mode of thinking. At the end of Chapter 8, the major conclusion is presented in this way:

The idea that space and time may form a closed surface without boundary also has profound implications for the role of God in the affairs of the universe. With the success of scientific theories in describing events, most people have come to believe that God allows the universe to evolve according to a set of laws and does not intervene in the universe to break these laws. However, the laws do not tell us what the universe should have looked like when it started - it would still be up to God to wind up the clockwork and choose how to start it off. So long as the universe had a beginning, we could suppose it had a creator. But if the universe is really completely self-contained, having no boundary or edge, it would have neither beginning nor end; it would simply be. What place, then for a creator?

Many people have interpreted all this as a ringing endorsement of atheism, by a famous physicist of excellent credentials. But there are a few problems with it. First of all, those interested in the interface between science and religion (see, for example, Haught 2000) have long since set aside the "clockmaker" concept of God. Second, the phrase "... space and time may form a closed surface without boundary..." doesn't mean very much to those outside the fields of physics and mathematics; consequently, many readers shrug off this concluding paragraph, thinking "golly, Hawking sure has a deep and profound viewpoint here... I wonder what it means?" Seldom is this concept explored in any detail.

When we do explore it in detail, we find a disconnect in the transition between the use of mathematical symbols and terms, and the way language is customarily used.

The first part of chapter 8 describes the big bang. It contains science that is noncontroversial among physicists. Subsequently, Hawking sketches a little of the anthropic principle (Barrow and Tipler 1986), mentions the fine-tuning of certain fundamental numbers (Rees 1999) which are necessary for our existence, and describes the "inflationary universe" theory (Guth 1997).

## MATHEMATICAL CONSTRUCTS

Hawking works very hard in chapter 8 to express in laymen's language a number of important concepts that are used in theoretical physics. There is the usual suppression of scientific notation (probably done at the publisher's insistence); e.g., the simple number  $10^{17}$  is replaced by the locution "...hundred thousand million million ...." More significant, Hawking tries to explain the concept of a *Feynman Path Integral* (see, for example, Quigg 1983), which is a most useful tool that combines the mathematical representation of space and time in an elegant formalism.<sup>1</sup> Basically, this is a technique that is rooted in functions of a complex variable, which is taught in third year calculus [see, for example, Hildebrand 1949].

In order to deal properly with *Feynman Path Integrals*, the concept of *imaginary time* is introduced on p. 134, and here is where the danger begins. By analogy with imaginary numbers, which exist in a dimension orthogonal (perpendicular) to the real number line, physicists introduce the combination  $iCt = x_0$ , to place the time variable on the exact same footing as the spatial variables  $\{x, y, z\}$ . Here  $C$  is the speed of light, in meters/second. The resulting *imaginary time*  $x_0$  is a spatial quantity with esdimensions of meters. This enables all four dimensions (3 space and one time) to behave in the same mathematical way.

(One point needs to be noted: the choice of the adjective *imaginary* was a bad choice 200 years ago for describing complex numbers, and it remains a bad choice today when applied in various branches of physics and engineering. It would be better to use terminology such as *horizontal* and *vertical* components of numbers.)

Many readers are mystified by the label *imaginary*, and glaze over because of it, continuing to read with a mild detachment. The point that few readers have noticed is that *imaginary time* has ceased to be a time-variable; it's a spatial dimension, converted from seconds to meters by multiplying by the speed of light ( $C$ ):  $iCt_{re} => t_{im}$ . Hawking states quite clearly "the distinction between time and space disappears completely" and "In Euclidean space-time there is no difference between the time direction and directions in space." Those are accurate statements about mathematical physics.

However, it must be remembered that certain common



constructions of thought and speech are likewise abridged when dealing with space-time in this way. Failing to attend to that limitation takes us down the path of error. In particular, it is illegitimate to treat space and time on the same footing mathematically while preserving a distinction between them in words. Hawking writes "...we may regard our use of imaginary time and Euclidean space-time as merely a mathematical device (or trick) to calculate answers about real space-time." At that point he enters the danger zone.

With time and space on an equal footing, we read: "Space-time would be like the surface of the earth, only with two more dimensions. The surface of the earth is finite but it doesn't have a boundary or edge; ..." So far so good. But on the very next page (p. 136), Hawking re-introduces time-laden words such as *began* and *starts* and *predictions*.

It is not much of a digression for a religious person to point out at this juncture that if we can think of the 4 dimensions of space time as a coherent coordinate system, surely it can't be too difficult for God to see the universe in that way as well. Perhaps the biggest mistake made by so many scientists is to think that God is restricted to experiencing the passage of time in the same way we do. When we (by mathematical abstraction) group all 4 dimensions together in a Euclidean space-time, we are treating all points in space and *all points in time* uniformly, seeing them "all at once." God can do that, not abstractly but in reality; the term for it is *omnipresence*. Perhaps the children's song should be rewritten: "He's got the space-time continuum in his hands..."

Some 1600 years ago, St. Augustine said that God created space and time together. That's a truly exceptional insight for someone who never heard of general relativity! If some modern critic wants to disbelieve in a god who is subordinate to time, okay; but I would insist on this point: don't confuse that limited god with the God described by St. Augustine and others over the centuries.

#### MIXING SPACE WITH TIME

On p. 137 Hawking takes this Euclidean space-time and maps it onto a sphere, which is displayed on p. 138. In that drawing, the radius of the universe is given by  $z \sin \theta$  and the *imaginary time* is given by the distance from the North Pole,  $s = R_0 \theta$  (where  $R_0$  is the maximum diameter of the universe). Left unstated is that the "origin of coordinates" for this geometry is **not** at the North Pole; it is at  $x = y = z = 0$ . The text reads "The universe starts at the North Pole as a single point. As one moves south, the circles of latitude at constant distance from the North Pole get bigger, corresponding to the universe expanding with imaginary time."

It is at this point that the spatial dimension *imaginary time* has been conflated with real time. Words like *starts*, *moves*, *gets bigger* and *expanding* are associated with the passage of *real* time, not the space-like *imaginary time*. (Moreover, it is not treating the variables symmetrically to map *imaginary time* into  $\theta$  while the usual spatial dimensions map into a function of  $z$  and  $\theta$ .) For the mapping into the geometry pictured, it really should be no wonder that an angular variable  $\theta$  (limited such that  $0 \leq \theta \leq 2\pi$ ) has no singularities.

The north pole of the sphere corresponds to the maximum of the  $z$ -coordinate, and Hawking chooses to assign that the value  $t_{\text{real}} = 0$ . Soon thereafter, he jumps into terminology applicable to *real* time, using words like *would*, *years ago*, and *eventually*. Returning to reality, he states "Only if we could picture the universe in terms of imaginary time would there be no singularities."

The error that pervades this discussion is the treatment of *imaginary time* as though it were a form of time, rather than a spatial dimension.

Hawking makes a transition from mathematical abstraction to people's minds when he writes ". . . so-called imaginary time is really the real time, and that what we call real time is just a figment of our imaginations.... So maybe what we call imaginary time is really more basic ...." But then he glides to the conclusion "So it is meaningless to ask: Which is real, "real" or "imaginary" time? It is simple a matter of which is the more useful description." A decade after this book, along came (Clinton 1998) the sentence "It depends on what your definition of is is." There seems to be some similarity.

Hawking's transition deserves considerable scrutiny. Only one who is entirely transcendent to both space and time can possibly grasp all space and all time "at once", which is a characteristic associated with *imaginary time*. Human beings can't do that. We are constrained by our thought processes, culture and language to deal with time passing as on a clock. We can't construct three consecutive sentences without a built-in reference to time (Try it!). Physics is often said to be the science of motion, and that implies a change over *time*. That is, *real time*. The "*more useful description*" is definitely the one that can be communicated between people, and that is the one that treats *real time* as real, and regards *imaginary time* only as a useful mathematical construct for carrying out integrals over the entire allowed range of dimensional parameters.

To become comfortable with *imaginary time*, you have to step outside of space and time. None of us has done that yet. St. Paul writes "...we see now as if in a mirror, imperfectly; but then we shall see face to face..." — even St. Paul (or his translator) falls into using the time-



associated word *then*. Our ability to communicate dwindles when we try to speak from a position outside of real time.

In the final pages of chapter 8, the conflation of *imaginary time* with *real time* is continued, under the label of the *no boundary proposal* or *no boundary condition*. The ambitious conclusion is "Thus all the complicated structures that we see in the universe might be explained by the no boundary condition for the universe together with the uncertainty principle of quantum mechanics."

The final confusion is in the closing words cited at the outset of this essay: "... if the universe ... [has] no boundary or edge, it would have neither beginning nor end: it would simply be." The lack of a boundary is a property of *imaginary time*; words like *beginning* and *end* are associated with real time.

## CONCLUSION

It is an important aspect of Christian theology to say that God creates and sustains the universe "constantly" - a nod to our own time-dependence there. Theologians can quote St. Augustine to physicists and add the quip "we told you so!" Everybody involved in the science/religion interface needs a major dose of humility (Templeton 1995), first to understand others, and then to look beyond our meager human perceptions.

Hawking's final question, "What place, then, for a creator?" would probably elicit a put-down from St. Augustine (judging by what else he had to say in *The City of God* about theological speculators). Looked at more charitably today, perhaps *A Brief History of Time* serves a useful purpose: by demonstrating how readily the limited-thought processes of humans lead into error, it helps us realize that God comprehends the universe, including both *space* and *time*, in a far more advanced way.

## ENDNOTES

<sup>1</sup> When using mathematics to do physics, and confronted by a mathematical singularity, it is not uncommon to transform into a different coordinate system, and carry out the math there. The *LaPlace Transform*, familiar to most engineers and hidden intrinsically in every TV set, is an example of that kind of mathematical manipulation.

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