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THE EFFECT OF THE SCIENTIFIC REVOLUTION ON SPANISH FICTION AS REVEALED IN SELECTED WORKS (1789-1969)

DISSERTATION
Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of the Ohio State University

By
Shirley Ahlers Williams, B.A., M.A.

The Ohio State University
1972

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INTRODUCTION

The idea that science has had a considerable influence on literature is hardly original. Many prominent authors and critics have commented on the relationship between these two disciplines, realizing as Charles Glicksberg does that:

Though literature is part of a continuing tradition, with its established genres, structures and styles, the tradition undergoes marked changes in the course of time....These changes...are to be accounted for in large measure by a radical transformation in the consciousness and sensibility of an age. When the world view is suddenly disturbed violently...the writer is forced to experiment with new forms of expression....Such a radical transformation of the world image took place in post-Enlightenment thought from 1750-1970.

Glicksberg goes on to develop the idea that this "radical transformation of the world image" is due, on the whole, to changes brought about as a result of the Scientific Revolution which occurred between 1500 - 1700.

Many other authors have made valuable contributions to the study of the relationships between science and literature on what might be termed the theoretical level. For example, in his recent book Literature and Science, Aldous Huxley has attempted to answer such questions as:

What is the function of literature, what is its psychology, what the nature of literary language? And how do its function, psychology and language
differ from the function, psychology and language of science? What, in the past, has been the relationship between literature and science? What is it now? What might it be in the future?2

While Sypher attacks still a different aspect of the theoretical relationship between literature and science in Literature and Technology. In this excellent book, Sypher proposes the interesting thesis that from the late nineteenth century, "Illogically enough, the most literary literature reacted against an increasingly technological culture by resorting to a refinement of technique."3 Thus literature became preoccupied with method and technique precisely at the same time that science itself was identified with the use of particular methods.

Still other authors have attempted to trace the influence of science in particular national literatures. For example, Norman A. Jefferes (Language, Literature, and Science), B. Ifor Evans (Literature and Science), and many other authors4 have worked with English literature, and shown how specific English writers were influenced by the writings or ideas of specific scientists of the same periods. It is perhaps natural that so many works have been written dealing with the influence of science on English literature, for, after all, many of the most important advances in science were made by English scientists from Francis Bacon, "the father of science," to such imposing later figures as Newton and Darwin. The influence of these advances would, quite naturally, be felt firstly and perhaps most powerfully in their own countries, and would immediately affect their own national literatures.
In contrast to the many works dealing with science and English literature, one is impressed by the notable lack of works dealing with the relation between science and Spanish literature. Again the logical explanation may be that Spain herself produced hardly any scientists of note and, as we shall see, often tended to resist the influence of the new scientific ideas born in England and France. Since the influence of the new sciences was less in Spain than in these Countries, Spanish literature can logically be expected to be less affected by the new ideas. But the fact remains that the changes brought about during the Scientific Revolution resulted in a universal change in world view, and even Spain was not exempt from this change. Science did affect Spanish literature, even if its effect was perhaps not as profound as it was in other European literatures.

Sherman Eoff is one of the few critics who has written on the relationship between science and Spanish literature, and his book *The Modern Spanish Novel: Comparative Essays Examining the Philosophical Impact of Science on Fiction* is certainly one of the most valuable books on this topic. Eoff writes:

One can hardly overemphasize the fact that science has had a tremendous influence on man's conception of himself as an individual, and we should not underestimate the literary significance of the subject.

In his work, Eoff considers the Spanish novel of the nineteenth and twentieth century and attempts to demonstrate that these novels show the philosophical impact of modern scientific developments. Specifi-
cally, these novels illustrate their author's attempts to reconcile
the implications of these scientific developments and man's fundamental
need to preserve some sense of the religious sentiments which science
tends to destroy.

It is the premise of this dissertation that science has had a
much broader impact. In addition to destroying man's faith in reli-
gion, science has changed man's entire world view. This change can
be seen in Spanish fiction because literature acts as a mirror,
faithfully recording the dominant world concept of its time. The
kinds of explicit and implicit statements authors of fiction make
about the discipline of science itself reveal quite dramatic changes
in world view.

For example, we will see that the birth of modern science was
accompanied by an almost incredible optimism. By using science, it
was felt man could conquer nature and create utopia. This spirit of
optimism regarding science is seen throughout Spanish literature in
the eighteenth and nineteenth centuries. In the twentieth century,
however, two world wars and new scientific and technological develop-
ments have given birth to a new attitude towards science. We begin
to notice a marked pessimism in fiction, a fear that man has lost
control of his own destiny and is becoming the victim of a run-away
technology that is resulting in the alienation and ultimate destruc-
tion of the individual. Concurrently with this change from optimism
to pessimism, we will see changes in man's concept of the relationship
between himself and society and science and morality.
The purpose of this dissertation will be to coordinate key events in the history of science with representative Spanish fiction of the same periods in an attempt to see what added dimension literature can bring to our understanding of the transformation in world view occasioned by the Scientific Revolution. Fictional works to be examined will include: Cartas marruecas (1789), El caballero encantado (1909), Amor y ciencia (1905), Amor y pedagogía (1902), Tiempo de silencio (1962), and Corte de corteza (1969). Many other works of Spanish fiction could, of course, have been included. These six works are certainly not to be seen as the only Spanish works showing the relationship between science and fiction. They were chosen because they are works of major authors who may be considered as representative of the general trends discussed, and because these particular works provide especially explicit comments on the way in which their authors regard science.

During the course of this dissertation, I hope to show the interrelationships between what C.P. Snow refers to as the "two cultures" of science and literature, and in so doing to lead to a better understanding of the interrelationship of both these disciplines. My dissertation does not pretend to present an all-inclusive or technical history of science. Students interested in technical histories may consult the appropriate works listed in the bibliography. I will describe only those scientific theories which I feel to have had the greatest influence on literature and will describe these theories only in the most general terms. Students of the sciences will
perhaps feel that my treatment of these theories is over simplified, which is possibly true. I can only say that in dealing with complicated scientific theories the choice was often between a possible over-simplification or probable unintelligibility for the uninitiated reader. Also, I do not mean to imply that a study of the general history of science can in any way replace the actual study of science, but I do feel that, as J. Bronowski states, a study of the history of science:

...gives us the backbone in the growth of science; so that the morning headline suddenly takes its place in the development of our world. It throws a bridge into science from whatever humanist interest we happen to stand on. And it does so because it asserts the unity not merely of history but of knowledge. The layman's key to science is its unity with the arts. He will understand science as a culture when he tries to trace it in his own culture.  

If this dissertation succeeds in establishing a rather modest bridge between some of the major developments of modern science and the above mentioned works of Spanish fiction, its purpose will have been achieved.


4. For a more complete listing of such works, consult the final bibliography.

5. There is perhaps only one Spanish scientist of international reputation: Santiago Ramón y Cajal, a physician (1852-1934), who received the Nobel Prize for medicine.


7. C. P. Snow, *The Two Cultures and the Scientific Revolution*.

CHAPTER I

THE SEVENTEENTH CENTURY: THE RISE OF MODERN SCIENCE

In order to understand the sweeping scientific changes brought by the seventeenth century, it will be necessary to examine briefly the medieval scientific concepts which governed men's thinking before the Scientific Revolution.

The medieval scientific system had been taken from the ancient Greeks, particularly Aristotle. In the simplest of terms, the medieval structure was based on a hierarchical ordering of nature. Things were ordered into likes and unlikes and their behaviors were explained in terms of obedience to their ideal natures. For example, the medieval answer to Newton's gravitational question: "Why does an apple fall downward to the ground?" would undoubtedly have been: "The apple falls down and not up because it is its nature to fall down." This answer is, of course, an oversimplification. What the Aristotelians meant was that apples fall down and not up because it is the nature of all earthy things to always fall down. As J. Bronowski explains it:

They saw a likeness between all masses, and they used it to order the world around them into different categories of things, earthy, watery, airy and fiery. It was a far-reaching theory, and it was applied to the body and the mind as well as to dead matter. But what interests us now is the kind of structure which it gave to the universe. In that structure, earthy things belonged to the earth; their natural resting place was the centre of the earth; and they fell to
the earth in their longing for that. What buoyed the universe and kept it from finding the state of dead rest in its natural centres was the tug of war between the elements, earthy matter carried off by the action of fire, water swept up in a rush of air. The universe lived by the tension between the elements, all at cross purposes because all in search of their different centres. 

Underlying this whole conception was a kind of order which was really a hierarchy. The whole structure implied the concept of nature as it ought to be: the order towards which the universal design was striving, and in achieving which it would be transfigured and come to rest. According to the medieval conception: "The world is disorderly, and it seeks its order in the great ideal hierarchy of how it ought to be. And it ought to be a still perfection." 

This vision of the universe was obviously not the product of observation and experiment, but of pure intellectual speculation. Indeed, until Francis Bacon, men held to the belief that the workings of nature could be understood by intellectual insight alone. Going out of doors and insisting upon observation and experimental proof was, as Calder puts it: "defiance of authority in an age when men of learning could seriously argue that eggs that were most nearly round would produce cockerels." Calder's description of the medieval justification of this theory vividly emphasizes the fact that the medieval mind was above all logical, but that this logic did not, as these thinkers believed, inevitably lead to truth. Their syllogisms could be perfectly valid, that is logical, and yet still be false. Calder notes that medieval thinkers justified the idea of cocks hatching from more nearly round eggs on the grounds of Platonic perfection and says:
They insisted that all heavenly bodies must be perfect spheres, moving in perfect circles; the male sex was more powerful than the female; the hen, being the imperfect sex, could not lay perfect spheres, only pointed-ovals; but some eggs were less imperfect than others -- nearer the ideal round -- and from these, cockerels would hatch. To go into the hen-house to see what actually happened would have been an affront to reason.4

Clearly in order for science to advance, this type of pure intellectual speculation had to be coupled with a new appeal to fact. Men had to turn to direct observation of nature and to experiment. This was the message of Francis Bacon. And from this new emphasis on scientific method and experiment was born the idea of causes which acted as one aspect of the great division between the Middle Ages and the Scientific Age. According to Bronowski:

We could say that the Middle Ages saw nature as a striving towards its own inner order, and that the Scientific Revolution overthrew this order and put in its place the mechanism of causes. ... In looking at the events of high tide at Greenwich or an eclipse at the Hague, it looked not at the nature of water or fire, but looked to other events, forward and backward. The Scientific Revolution was a change from a world of things ordered according to their ideal nature to a world of events running in a steady mechanism of before and after.5

Let us then turn to a consideration of some of the major thinkers who produced this revolution in scientific thinking.

A) FRANCIS BACON (1561-1626)

Francis Bacon, a noted English philosopher, lawyer, essayist and statesman, is perhaps best known in literary circles for his fine Essays (1597-1623). But our concern will be chiefly with the works
written as part of the *Magna Instauratio*, Bacon's Great Reconstruction of philosophy. These works contain the germinal ideas which were to revolutionize the study of science. Will Durant outlines Bacon's plan for his great work as follows:

First of all, he tells us in his 'Plan of the Work,' he would write some Introductory Treatises, explaining the stagnation of philosophy through the posthumous persistence of old methods, and outlining his proposals for a new beginning. Secondly he would attempt a new Classification of the Sciences, allocating their material to them, and listing the unsolved problems in each field. Thirdly, he would describe his new method for the Interpretation of Nature. Fourthly, he would try his busy hand at actual natural science, and investigate the Phenomena of Nature. Fifthly, he would show the Ladder of the Intellect, by which the writers of the past had mounted towards the truths that were now taking form out of the background of medieval verbiage. Sixthly, he would attempt certain Anticipations of the scientific results which he was confident would come from the use of his method. And lastly, as Second (or Applied) Philosophy, he would picture the utopia which would flower out of all this budding science of which he hoped to be the prophet. The whole would constitute the *Magna Instauratio*, The Great Reconstruction of philosophy.

Such an impressive undertaking could hardly fail to have a revolutionary effect.

Let us then examine in some detail Bacon's ideas concerning the re-organization of science which are to be found mainly in *The Advancement of Learning* (1603-05) and the *Novum Organum* (1608-20).

In *The Advancement of Learning*, Bacon begins by making a general survey of the state of the sciences, dividing them each into their distinctive fields. He then examines their defects, needs, and possibilities and indicates new problems to be solved. At the end of his survey he comes to the conclusion that science alone is not enough:
...there must be a force and discipline outside the sciences to coordinate them and point them to a goal. What science needs is philosophy -- the analysis of scientific method, and the coordination of scientific purposes and results; without this, any science must be superficial.9

What is startlingly new in Bacon is the assurance with which he predicts that man will conquer and control nature. At first, there seems to be little reason for such optimism. After all, men had been searching for truth using Aristotelian scientific techniques for nearly two thousand years and their efforts had produced hardly any significant results. Why should Francis Bacon now hope for such great success when so many centuries of thought had yielded only such a modest result? Bacon answers by asking a revolutionary question and supplying an equally revolutionary reply:

...what if the methods men have used have been wrong and useless? What if the road has been lost, and research has gone into by-paths ending in the air? We need a ruthless revolution in our methods of research and thought, in our system of science and logic; we need a New Organon, better than Aristotle's, fit for this larger world.10

Philosophy has born so little fruit for so long, says Bacon, because she has been following the wrong methods. The great mistake of the Greek thinkers was that they spent so much time in theory and pure intellectual speculation and so little in observation. This weakness was, as we have seen, handed down to the medieval scientific thinkers who in general followed Aristotelian methods, and produced many absurd theories which simply did not hold up in the face of direct observation of nature.

Bacon's message is, then, that the medieval scientific apparatus
must be thrown out and forgotten. To renew herself science must begin anew with a clean slate and a cleansed mind. If one is to completely discard the medieval scientific method of ordering things into likes and unlikes and then of explaining their behaviors in terms of obedience to their ideal natures, then clearly some other new method must be supplied in its place. And Bacon devises just such a new method. He says in effect:

We must go to nature instead of to books, traditions and authorities; we must 'put nature on the rack and compel her to bear witness' even against herself, so that we may control her to our ends. We must gather together from every quarter a 'natural history' of the world, built by the united research of Europe's scientists. We must have induction.11

By the use of induction, Bacon supposed that the accumulation of empirical data would in time lead automatically to the discovery of the natural uniformities science sought. According to Bacon, the business of scientists was to pile experiment upon experiment, and to record results. Theorizing was a waste of time in the early stages of research. General truths or laws would emerge of their own accord when a large enough assembly of particular facts had been made. The use of the pure inductive method Bacon advocated has some obvious weaknesses -- modern scientific technique requires more than mere observation and accumulation of data; it also requires the formation of guiding hypotheses and the use of mathematics -- but Bacon's inductive method remains an important element in the method of modern science to the present day.

Throughout Bacon's writings, his emphasis is on the utility of
science. For by means of the careful accumulation of data which he recommends, we come, in his words, to the "form" of the phenomenon we study -- to its hidden nature or essence. But knowledge for the sake of knowledge is not the final goal of science:

We strive to learn the form of things not for the sake of the forms but because by knowing the forms, the laws, we may remake things in the image of our desire. So we study mathematics in order to reckon quantities and build bridges; we study psychology in order to find our way in the jungle of society. When science has sufficiently ferreted out the forms of things, the world will be merely the raw material of whatever utopia man may decide to make.12

Bacon himself describes such a utopia in his last work, *The New Atlantis*. Government in the New Atlantis rests in the hands of the members of Solomon's House, a select body of scientists and philosophers who have been carefully chosen by society to rule. But in reality there is little government as we know it in the New Atlantis. The governors of Solomon's House are more concerned with controlling nature for man's benefit than with ruling or governing man himself. The rulers state: "The End of Our Foundation is the Knowledge of Causes and secret motion of things; and the enlarging of the bounds of human empire, to the effecting of all things possible."13 The governors are engaged in essentially scientific pursuits designed to serve man. They experiment with animals in order to discover new surgical techniques; they experiment with plants and animals in order to develop superior strains for human use; they study the stars. They gather knowledge from all corners of the civilized world. Certain members of Solomon's House are sent abroad every twelve years to live among foreign
people and study their languages, science, industries, and literature. At the end of their twelve years abroad, these men return, bringing to the New Atlantis knowledge from all over the world.

Bacon's portrait of the utopian society in the New Atlantis is a brief one, yet its message had a tremendous effect. Man must first perfect science and then perfect the social order by putting science in control. We need only learn the laws of nature and we shall be her masters. Science is the road to utopia. Such is the message of Francis Bacon, and the note of optimism he struck goes ringing down across the years for more than two centuries.

How then can we summarize Bacon's contributions to the scientific revolution? The idea that man could use science to better his world and the spirit of optimism this idea generated should certainly be counted as one of his major contributions, for it generated the enthusiasm, the momentum that would lead to the later revolutionary discoveries of Newton, Darwin, and many others. His introduction of the inductive scientific method must, of course, be counted as another major contribution to modern science, because it cleared away the cobwebs of medieval scholastic speculation and sent men to a much more profitable direct observation of nature. But Bacon's inductive method per se -- the tedious accumulation of empirical data in order to discover the essence of natural phenomena -- has not proved to be the most fruitful method for modern science. Most of the tremendous advances in science were made not by the pure inductive method, but by the simpler method of hypotheses, deduction, and experiment. Perhaps
Bacon's chief weakness was that he underrated the importance of deduction and the power of mathematics. But the introduction of deduction and of mathematical logic to the scientific method was largely the contribution of our next great representative of the Scientific Revolution, René Descartes.

B) RENE DESCARTES (1596-1650)

René Descartes' habits of thought form a complete contrast to Francis Bacon's empirical approach. This contrast is evident in the anecdotes often repeated about the two men. Bacon is said to have died of a cold he caught when at the age of sixty-five he tried the experiment of stuffing a goose with snow in an early anticipation of modern refrigeration techniques. Descartes is said to have done most of his scientific work in bed. These two men, so different in personalities, became the representatives of two opposing schools of scientific thought in the seventeenth century. Bacon represented empiricism, the belief that knowledge of the world could come only inductively from experience and experiment. Descartes represented apriority, the belief that such knowledge could be obtained by pure thought based on intuitively known general principles. Advocates of the a priori method agreed in attaching little weight to the evidence of the senses. They regarded introspection and intuition, followed by deductive development, as surer sources of knowledge, and placed a great deal of confidence in mathematical methods as the means of
achieving this knowledge. Since Descartes came to represent this entire school of scientific thought, we should perhaps examine his philosophy of science in some detail.

For Bacon, the problem had been: How can we obtain information? But for Descartes the problem was: What is real and what is illusory? Descartes outlined his predominately mathematical method of distinguishing truth from falsehood in his famous *Discours de la méthode* (1637). Descartes believed that the reality of the universe could be revealed by mathematical logic:

The long chains of simple and easy reasonings by means of which geometers are accustomed to reach the conclusions of their most difficult demonstrations had led me to imagine that all things, to the knowledge of which man is competent, are mutually connected in the same way and that there is nothing so far removed from us as to be beyond our reach, or so hidden that we cannot discover it, provided only that we abstain from accepting the false for the true and always preserve in our thoughts the order necessary for the deduction of one truth from another.14

Following his own rules of reasoning, Descartes found that mathematics could be made to yield its secrets:

Not only did I reach solutions of questions I had formerly deemed exceedingly difficult, but even as regards questions whose solutions escaped me, I was enabled as I thought to determine the means whereby and the extent to which a solution was possible; results attributable to the circumstance that I commenced with the simplest and most general truths and thus each truth discovered was a rule available in the discovery of subsequent ones.15

Encouraged by his success with mathematics, Descartes began to feel that mathematics illustrated the way in which logical relationships
could interlock through the whole range of knowledge, and that all natural science should be held together in a logical, although not necessarily mathematical, framework.

The problem became then, how could the natural scientist obtain principles for the physical universe as certain as the axioms concerning lines and numbers which are the basis of mathematics? Again, Descartes answered this question through an analogy with mathematical methods, and reasoned that since geometry does not start with empirical measurements of lines and angles, science too should draw its first principles from reason. As A. R. Hall notes:

...in this [drawing first principles from reason] there was no great difficulty, for some physical concepts he took to be as obviously true as the foundation of arithmetic, one could apprehend that two bodies cannot be in the same place as clearly as that two and two make four. The proof that a vacuum in nature is impossible was as transparent to Descartes as the proof that the number of primes is infinite. Or again, that matter is extension was as clear and indubitable a definition as Euclid’s famous definition of a straight line. Such considerations, essentially drawing an analogy between the mathematical logic that already existed and the logic of physics that Descartes was trying to create, brought him to his crucial declaration: 'I concluded that I might take as a general rule the principle that all things which we clearly and obviously conceive are true; only observing, however, that there is some difficulty in rightly determining the objects which we distinctly conceive.'16

Descartes was thus extending the test of logical consistency, appropriate to the theorems of geometry, to the propositions of the natural sciences. But was this enough to guarantee truth? As Hall
points out:

To identify truth whether in science or mathematics with logical consistency would leave the first principles uncertain....On these the mind might err, however impeccable the deductions that followed afterwards. God was needed as the ultimate guarantor of truth and perfection and this for Descartes was the best proof of his existence, as certain as a demonstration in geometry....That is, God is the ultimate touchstone distinguishing reality from mere appearance, truth from falsehood....In the last resort human confidence in human reason could only derive from the certainty that 'all we possess of real and true proceeds from a Perfect and Infinite Being.'

Such, in brief, was the nature of Descartes' method. Its chief weakness was, as stated above, that the first principles which anchored Descartes' chain of reasoning remained uncertain. Descartes used his scientific method to construct an explanation for the system of the entire universe in his *Principes de la philosophie* (*Principles of Philosophy*), 1644. Starting from the assumptions that in nature there are no hidden forces, like gravity or magnetism, and that the universe is continuously and completely filled with matter, Descartes developed an extraordinarily elaborate mechanistic and corpuscularian "model" of the physical universe. He described the universe as being composed of three types of particles. These particles were not atoms, because he imagined them as being divisible, although in nature they were not normally divided. The first element was a fine dust, composed of irregular particles which completely filled the interstices between the larger particles. The second element (*matiere subtile or aether*) consisted of rather coarse spherical particles, easily set in motion.
The third element was composed of still coarser, irregular and sluggish particles. These three elements corresponded roughly to Aristotle's elements of Fire, Earth and Air. Since they were composed of the same matter, Descartes believed these elements could be transformed one into another. By theorizing on the different motions of the three types of matter, Descartes tried to account for all the phenomenon of physics. Indeed, he wrote at the end of his Principles, 

"...I can demonstrate by a very easy reckoning that there is no phenomenon in nature whose explanation has been omitted from this treatise."18

We will not examine all of Descartes' theories here, but we should perhaps examine the famous Theory of Vortices by which he explained planetary motions; the weaknesses of this theory will serve to illustrate the weakness of the entire Cartesian system. Descartes' Theory of Vortices was his one big attempt to reconcile the new astronomy with the old mechanics and physics. The old Aristotelian law of motion supposed that there must be something to urge the planets forward as well as something to guide them in their paths. Descartes adopted this idea and combined it with the view that there is no empty space or vacuum in the universe. Particles fill all space. Each planet, Descartes maintained, is at the center of a vortex, or whirlpool, in the space-filling fluid which surrounds it. The rotation of this vortex, which is most rapid at the center, gives the planet its axial rotation. The outer parts of the vortex carry any satellites circling the planet. The local planetary vortices are set in a larger
vortex, with the sun at its center, which carries them -- each with its own planet -- around the sun. This theory would explain why all the planets revolve in one direction around the sun, and why those nearer the sun move more quickly. The vortex theory also offered a superficial explanation of gravity, since given the fact the earth is at the center of a vortex, we can expect small objects to be drawn towards the center. Descartes' hypothesis was ingenious, but it had one serious flaw -- it could not be developed mathematically, and could therefore not be adequately tested. It was possible to predict, from Descartes' hypothesis, that the planets nearer the sun would move more quickly; but it was not possible to predict the precise relation between their distances and periodic times. Nor was it possible to predict the shape of the orbit which a planet would take as it was swept along in this complex system of vortices.

All of the other theories of the Principles suffer from similar flaws. A. Rupert Hall summarizes them all saying: "The Principles was a triumph of fantastic imagination which happens, unfortunately, never once to have hit upon a correct explanation." Hall goes on to explain that the shortcomings of the Principles were due to the fact that Descartes conferred certainty upon mere intuitions not directly dependent upon experience, and failed to tie theory to experiment and investigation. For example, why did Descartes contend that there were just three types of matter; why not two or four? Neither figure could be verified by experience or experiment, and thus one would seem to be as valid as another. As Hall puts it, Descartes' "unguarded, unre-
strained intuition slipped insensibly into sheer imagination."\(^{20}\)

If Descartes failed to contribute any valid scientific explanations for the workings of the universe, what then was his contribution to modern science? Descartes is largely responsible for developing the system of analytical geometry in his work _La Géométrie_ which he annexed to his Discours de la méthode pour bien conduire sa raison et chercher la vérité dans les sciences (1637). L.W.H. Hull believes that "...Descartes' most valuable achievement was not his metaphysics, or his Theory of Vortices, but his less spectacular invention of analytical geometry."\(^{21}\) Hall too emphasizes the importance of Descartes' geometry:

Analytical geometry rendered possible the later achievements of seventeenth-century mathematical physics; without this method the application of mathematics to science would have been stultified. The problems of physics -- especially mechanics -- presented themselves in spatial terms, that is, geometrically; by Descartes' discovery they could be subjected to the flexible and solvent attack of algebra.\(^{22}\)

Descartes' second important contribution to modern scientific method was, of course, his system of deductive logic, his emphasis on forming a bold and logical hypothesis. Descartes himself, as we have seen, failed to contribute any valid scientific explanations of the universe because he failed to make the connection between theoretical analysis and experiment. He formed the bold hypothesis, but then failed to take the next step -- to experiment to prove or disprove his hypothesis. It remained for our next figure, Sir Isaac Newton, to join Cartesian theory and mathematics with Baconian experimental methods.
It was this happy union that produced the powerful tool of modern scientific method as we know it today.

C) SIR ISAAC NEWTON (1642-1727)

Astronomy had had a long history of observations and discoveries before Newton. In fact, astronomy had already passed through a major scientific revolution, the Copernican Revolution, which placed the sun rather than the earth at the center of the universe and changed the entire medieval conception of man's place in the cosmos. Galileo's observations had added support to the Copernican system and his work on the laws of force and motion furnished a basis for the three laws of motion Newton would later formulate. Kepler too had made outstanding contributions to astronomy, explaining inconsistencies within the Copernican system by means of postulating elliptical planetary orbits and formulating his famous laws of planetary motion which formed an indispensable part of the foundation for Newton's discovery of gravitation. Thus in a very real sense Newton was standing on the shoulders of the giants who had preceded him. Yet Newton was a giant in his own right, for he recognized, as Descartes had not, that "Imagination, the ability to feign hypotheses, could give only the beginning of a theory in physics. To find out, to do everything, was to make a mathematical theory and confirm it by experiments or observations."23 For Newton, the laws of nature were not certainties of introspection, but those derived by mathematical reasoning. He therefore entitles
his most famous work The Mathematical Principles of Natural Philosophy (1687).

In this work Newton essentially took some very basic notions from Galileo concerning the behavior of masses: They travel in straight lines and at a uniform speed; they go on traveling thus unless a force displaces them, etc. Then Newton made the rather daring hypothesis that the rules which large masses seem to obey were also true of every piece of matter, regardless of its kind or size. Having established this idea, Newton went on to construct an entire world of his own, imagining that everything was composed of minute pieces of matter, each of which followed the same laws or axioms -- if they were at rest, they remained at rest; if they were moving they continued moving in straight lines until displaced by outside forces, etc. One of the forces that tended to displace matter was gravitation -- the attraction of other particles of matter. For Newton supposed that each minute particle attracted every other equal particle with a force which depended only on their distance apart, decreasing in such a way that when the distance is doubled, the force shrinks to a quarter. This, simply stated, was Newton's famous Law of Gravitation.

Newton's next step was to show the consequences of this law of gravity. He first showed that under this law an assembly of particles forming a compact sphere behaved towards anything outside the sphere simply like one heavy particle at its center. The simplicity of the mathematics which makes the planetary paths calculable depends critically on this fact.

But this was only the first step. Newton went on to show that
as a result of his theories, the orbits of the planets could be calculated; that they were indeed the elliptical orbits that Kepler had measured; and that they remained stable paths turning like a divine clockwork. He went on to calculate the tides, the paths of the comets, and to account for all the phenomena of nature by reference to these laws. Thus Newton proved that his speculative world fit the real world as we know it -- his laws could be used to predict all natural events.

Newton's method, therefore, represents the joining of the two separate schools of science, the rational and the empirical. He united Descartes' logical outlook with Bacon's experimental passion, and forged them into the powerful instrument of the modern scientific method.

But Newton's effect extended beyond the formation of a method. Because of the success of his method and the usefulness of the laws flowing from it

...Newton was enthroned not so much the leader of a school, but as a kind of emperor of science. His laws ranged from planets to corpuscular matter. To many, everything seemed intelligible in terms of matter and motion. Mechanical motions explained the cause of all natural effects.24

Indeed, much of the philosophy of the eighteenth and nineteenth centuries was extremely mechanistic, and many thinkers pointed to Newton's laws as the justification for their mechanistic analysis of events. Since we will be concerned with the idea of mechanism and the related idea of cause and effect in our study of the thought and literature of these periods, let us take the time at this point to briefly
define these concepts and to trace their genesis in the seventeenth century.

D) THE IDEAS OF MECHANISM AND OF CAUSE AND EFFECT

Mechanism is merely the belief that natural processes are mechanically determined and can be explained by the laws of physics and chemistry. The whole concept of mechanism implies the idea of cause and effect -- the motion of a given mass must be accounted for by means of some previous force, etc. The mechanistic conception of the universe, then, reduces the world to a machine whose workings are completely intelligible by means of the mechanical laws of motion and the effects of forces acting upon masses. As we have seen, both Descartes and Newton explained the universe in these terms. Descartes followed the Aristotelian belief that one body can influence another only by direct contact with it. He thus imagined a world full of particles in which any motion is merely a displacement or rearrangement, involving a constant impact of particle on particle. Under these conditions any movement tends to create a swirl or vortex in terms of which Descartes explained the motions of the planets.

Newton's laws of gravitation too explained the universe in mechanistic terms. The difference between his mechanical system and Descartes' is that Newton's gravitational laws presupposed the belief that one body can influence or attract another even though they are not materially linked, that is, even though they were separated by
space. Newton was never concerned with the mechanism (if any) by which bodies affect one another's motion. He was content to accept the fact that they do influence one another, and to provide the means of predicting the extent of the effect in any given case. He refused to consider what the cause of gravitation might be; he merely referred one phenomenon to another without referring anything to an ultimate cause. For Newton:

...matter is, and the laws of nature are, because God has willed them. The perfection of the laws implied for him a lawgiver, as the perfection of the architecture of the universe implied a cosmic design.25

Thus, with the exception of Newton's inability to explain the first cause, he was able to explain all natural phenomena mechanistically in terms of cause and effect as we understand it today:

That given a definite configuration of wholly material things, there will always follow upon it the same observable event. If we repeat the configuration, we shall always get the same event following it.26

The success of Newton's laws of gravity assured the acceptance of his mechanistic concept of a universe explainable in terms of cause and effect. As J. Bronowski states, the concept of cause played "a major part in clarifying what was new at the Scientific Revolution, and made Newton's world different from that of Aristotle. When the world became a machine, this became the God within the machine."27 We will see these ideas of mechanism and cause and effect elaborated by thinkers of the next century, The Age of the Enlightenment.

2. Ibid., p. 24.


4. Ibid., p. 6.

5. Philosophy in Bacon's time referred to "all knowledge", and thus included the sciences.


8. The works which Bacon actually completed under the above mentioned headings are chiefly these:

   I. *De Interpretatione Naturae Proemium* (Introduction to the Interpretation of Nature, 1603); *Redargutio Philosophiarum* (A Criticism of Philosophies, 1609).

   II. *The Advancement of Learning* (1603-5).

   III. *Cogitata et Visa* (Things thought and Seen, 1607); *Filum Labyrinthi* (Thread of the Labyrinth, 1606); *Novum Organum* (The New Organon, 1608-20).

   IV. *Historia Naturalis* (Natural History, 1622); *Description of the Intellectual Globe* (Description of the Intellectual Globe, 1612).

   V. *Sylva Sylvarum* (Forest of Forests, 1624).

   VI. *De Principiis* (On Origins, 1621).

   VII. *The New Atlantis* (1624).

9. Ibid., pp. 96-97.

10. Ibid., p. 99.

11. Ibid., p. 103.

12. Ibid., pp. 103-104.


15. Ibid., p. 17.


17. Ibid., pp. 112-13.

19Hall, op. cit., p. 120.

20Ibid., p. 115.


22Hall, op. cit., p. 93.

23Ibid., p. 296.

24Calder, op. cit., p. 25.


26Bronowski, op. cit., p. 39.

27Ibid., p. 40.
CHAPTER II

THE EIGHTEENTH CENTURY: THE NEW SCIENCE ENTERS SPAIN

Newton's great work of synthesis was over before the eighteenth century began. In 1699, Newton accepted the position of Master of the Mint in England, and henceforth did no significant scientific work. J. Bronowski sees in Newton's achievements a symbol of the whole Scientific Revolution and believes his later loss of interest in science is equally symbolic of what he refers to as the "decay of science in the eighteenth century." There was, actually, little progress in science in the eighteenth century. Paradoxically enough this lack of progress can be attributed, at least in part, to the very success of the Newtonian method. As we have noted, Newton's work depended on the observations and experiments of generations of astronomers from the ancient Babylonians to Galileo and Kepler. Newton's work was essentially only an ordering of all of these previous works. He merely developed a system of mathematical shorthand that accounted for the phenomena others had observed for centuries.

The success of the Newtonian system inspired men of the eighteenth century to imitate his methods, and they attempted to impose similar mathematical systems of ordering in all of the various sciences -- biology, geology, medicine, etc. Their attempts bore little fruit, and actually stifled any further scientific development for nearly a
century. Their failure can be attributed to several causes. Firstly, there is really no reason to suppose the mathematical method is appropriate to every science. Secondly, even in those sciences where it is appropriate, it cannot be applied until that science has a long history of observations which will lend themselves to a mathematical ordering. In the eighteenth century there was no science with an orderly history of observations except astronomy, and Newton's work left little to be done in this field. Thus the attempt to apply Newton's methods to the other sciences in the eighteenth century led science as a whole down a blind alley.

Therefore, the only important scientific work in the eighteenth century was done not by mathematician-synthesizers like Newton, but by a collection of sometimes eccentric observers and collectors -- men who roamed Europe and America collecting fossils, plants, and geological samples. Perhaps the greatest of these eighteenth century collector(observers was the Swedish naturalist Linnaeus who devised the botanical system of classification by species and families which is still used today.

Botany and the natural sciences were not the only disciplines to profit from the new emphasis on observation. Medicine too began to reap benefits. Some great advances had been made in the seventeenth century. For example, it was then that William Harvey discovered the heart's function as a pump in the circulation of blood. But many other important advances were made in eighteenth-century medicine as a result of scrupulous observations. Men began to abandon the useless practice
of attributing all diseases to some imbalance in the four humors, and
began to observe the symptoms which characterized one disease and not
another. Doctors were at last able to define a particular disease
and distinguish it from other similar diseases. They stopped calling
it merely "fever" and instead recognized it as typhus or malaria or
influenza. Once a specific diagnosis could be made, the way was
opened for experiment to find a specific cure. One can see this
method at work in the steps by which smallpox and cowpox were shown
to be related, and a preventive treatment was worked out, first by
infection and then by inoculation -- from Lady Mary Wortley Montagu
at the beginning of the eighteenth century to Dr. Jenner at the end.

The discoveries of Linnaeus and Jenner were, of course, signifi-
cant, but they could not compare to the epoch-making advances of
seventeenth century science. The eighteenth century must be seen, on
the whole, to be an infertile period in the history of science. The
importance of the eighteenth century does not lie in the significance
of the few scientific discoveries it produced, but rather in the fact
that, firstly, the work of Linnaeus and men like him laid the ground-
work for the tremendous advances in the biological sciences which we
will see in the nineteenth century and, secondly, the eighteenth cen-
tury provided a fertile climate for the dissemination of the discover-
ies of the previous century. This spread of knowledge was accomplished
chiefly by means of the movement we know today as the Enlightenment.
A) THE ENLIGHTENMENT

The Enlightenment was an intellectual movement which affected all of Europe. It was a movement composed of many currents of new thought, but almost all of these new ideas owed their origin to the newly found freedom from the religious thinking of the Middle Ages. For after the waning of the Middle Ages a gradual change began to take place in the intellectual spirit of Europe which was to culminate in the eighteenth century. "Religion, which had been the medieval basis for men's thinking on the problems of life, was slowly driven from its prominent position by knowledge of a more secular kind."²

As del Río notes:

Se rechaza la idea de un mundo preordenado de acuerdo con los designios divinos. Se pone en duda la autoridad de la revelación, la tradición, la teología y la escolástica como fuentes de conocimiento. Y se proclama, en cambio, como medios de alcanzar la verdad a la razón y los sentidos (base de la filosofía), a la experiencia (base de la ciencia) y a la acumulación de noticias (base del saber enciclopédico).³

The medieval religious idea that happiness was to be obtained only in the other world, after death, was replaced by the idea that happiness could be attained here, now, in this world. By using his powers of reason and the tools of science and education, man could progress; he could build a perfect society. To do this, it was only necessary to remove the obstacles of superstition and ignorance which opposed this progress. Thus the Enlightenment was, as Paine put it, "The Age of Reason," for enlightened thinkers never doubted that the
intellect was the ultimate human test of all truth and all good. Let reason be freed, they said, and it would in a few generations build utopia.

Still another current of enlightened thought replaced the medieval hierarchical ordering of society into classes with the idea that all men are equal. Thinkers of the Enlightenment spoke of the natural rights of all men, and felt that their social relationships with one another should be determined by mutually agreed upon social contracts instead of being determined merely by their position in the hierarchical class structure.

All of these various currents of Enlightenment thought found their expression in the famous French Encyclopedia (1751-72), and it was chiefly through the French Encyclopedists that they were spread through all of Europe.

Since the chief characteristic of Enlightenment thought was its secular nature, it was therefore natural that because of the stricter control of thought in Catholic countries, Protestant lands usually took the lead in the new movement. In England, as we have seen, Francis Bacon opened seventeenth century scientific thought by dismissing Aristotelian authority in favor of direct observation of nature as the source of knowledge. Also in England, Isaac Newton closed the century by publishing his law of gravitation. In philosophy John Locke formulated the sensationalist theory of epistemology -- the belief that all knowledge comes from sense impressions. Thus by the end of the seventeenth century, the basis for a lay or secular outlook on life had
been established in Protestant lands like England. The next one hundred years was to see its penetration into Catholic countries and diffusion throughout Europe.

This diffusion began early in the eighteenth century when Voltaire returned from exile in England, bringing with him an admiration for Newton's new scientific thought and Locke's philosophy. Voltaire's enthusiasm was soon shared by a group of men who were referred to derisively as *philosophes*. As Richard Herr describes them:

Motivated by a deep faith in the ability of the human mind to learn the truths of nature through observation and reason, these men questioned all accepted beliefs. Locke's sensationalist theory of epistemology was carried to an extreme form by Étienne Bonnot de Condillac and Claude Adrien Helvétius. The concept of natural religion became common, and even the need for the existence of God to explain natural phenomena was denied by materialist writers such as Baron d' Holbach. The philosophes introduced their sensationalist and empirical spirit into a gigantic venture undertaken to gather all knowledge into one work of reference. This was the *Encyclopédie*, edited by Denis Diderot and Jean le Rond d'Alembert....

It is obvious, then, that the French Encyclopedists owed a great deal to the English leaders of the seventeenth century Scientific Revolution, and they themselves freely acknowledged this debt. Indeed, they dedicated the *Encyclopedia* to Francis Bacon:

'If,' said Diderot in the Prospectus, 'we have come of it successfully, we shall owe most to the Chancellor Bacon, who threw out the plan of a universal dictionary of science and arts, at a time when, so to say, neither arts nor sciences existed. That extraordinary genius, when it was impossible to write a history of what was known, wrote one of what it was necessary to learn.'
Voltaire and the Encyclopedists were largely responsible for the spread of the new science born in the seventeenth century. By means of the Encyclopedia the ideas of Bacon, Descartes, Newton, and the other leaders of the Scientific Revolution were spread through the continent. But in the hands of the Encyclopedists, much of this thought underwent a rather radical transformation as is obvious in the French treatment of Newton's physics.

Newton's conception of the universe was, as we have described it, mechanistic. Yet for Newton this mechanistic system did not conflict with religious beliefs. Quite the contrary, the perfection of the Universal laws as he saw them implied a lawgiver and the perfection of the architecture of the universe implied a cosmic design:

Though the planets and comets may indeed continue in their orbits by the mere force of gravity yet they could by no means have at first derived the regular positions of their orbits from those laws...it is not to be conceived that mere mechanical causes could give birth to so many regular motions, since the comets range over all parts of the heavens in very eccentric orbits...and in their aphelions, where they move the slowest and are detained the longest, they recede to the greatest distances from each other, and hence suffer the least disturbance from their mutual attractions. This most beautiful system of the sun, planets and comets could only proceed from the counsel and dominion of an intelligent and powerful Being.

Newton even assigned God certain duties within the universal system. In the Principia, he made God a sort of bureau of standards, charged with maintaining the even flow of space and time. Later on, in the Opticks, he found similar duties for the Deity:
He had already remarked in the *Principia* that God had set the fixed stars at remote distances so that they would not collapse together in the middle of space, as they might be supposed to do under the influence of gravitation. In the later works he makes it one of God's functions to keep the stars from falling together. He also assigns to God the duty of watching over other aspects of the celestial mechanism, particularly with regard to comets and planetary irregularities, where a periodical readjustment seemed to be needed. God was supposed to intervene when the irregularities reached the point of endangering the harmony of the celestial plan.

By assigning these duties to God, Newton felt that he had not only safeguarded theology by giving it new scientific supports, but that he had also filled in the gaps in his scientific scheme. But as things turned out, this conception of God the mechanician hardly proved a safeguard for religion. By the end of the eighteenth century the French astronomer Laplace had extended the mechanism of gravitation until he demonstrated the inherent stability of the universe by showing that all the irregularities are periodical and subject to a law which keeps them in bounds. In other words, the mechanism of the universe was self-sustaining, and there was no need of "such a hypothesis as God."

Laplace went even further and proposed the deterministic theory that:

...given the whereabouts and speeds at this instant of every atom in the universe.... you can forecast the fate of the universe, its molecules and its men, its nebulae and its nations, from now into eternity. And more than this: you can go backward in time as well as forward, and reconstruct the past to eternity.
Of course, Laplace realized that there was little possibility of actually carrying out such a calculation. But nevertheless, science remained for Laplace the discovery of the causal laws which would enable men to more nearly approximate this type of prediction. Laplace's deterministic theory allows no place for human action. There can be no free will; men simply go through the motions of acting out behaviors that are completely predetermined.

In summary, Voltaire enthusiastically advocated Newtonian physics, partly because he recognized its merits, but partly to undermine the civil and ecclesiastical authority he hated. In order to undermine this ecclesiastical authority, Voltaire and the French Encyclopedists writing under his influence eliminated the need for God within Newton's universal system and instead of seeing the perfection of the universe attesting to the glory of God, as Newton had, the French taught that the Newtonian system indicated reality as a great machine, in all essentials already known, so that man, body and soul, became part of an invincible and mechanical necessity.9

Voltaire illustrates this belief when he remarks in his Ignorant Philosopher that:

It would be very singular that all nature, all the planets, should obey eternal laws, and that there should be a little animal, five feet high, who, in contempt of these laws, could act as he pleased, solely according to his caprice.10

This mechanistic philosophy went hand in hand with the absolute determinism expressed by Laplace. Both mechanism and its allied philosophy of determinism, offer rather grim metaphysical possibilities, but as
Ginzberg notes:

The metaphysical horrors of scientific mechanism were not much felt in the eighteenth century, while the banishing of God as a needless hypothesis was marked by a tremendous burst of optimism and human selfconfidence. The eighteenth century possessed few of the great mechanical inventions which were to revolutionize human life in the nineteenth century, but intellectually it already had all the confidence in human success. During no century, indeed, was the belief in unlimited progress so widespread as in the eighteenth, and this faith in progress was due to the success of the Newtonian science -- a success which redounded, not to the greater glory of God, but to the greater glory of man.11

The "metaphysical horrors of scientific mechanism" were, however, to make themselves felt, as we shall see, in the nineteenth century.

B) THE ENLIGHTENMENT IN SPAIN

The ideological climate in which the Spanish intellectual of the eighteenth century found himself had been shaped largely by ideas which were foreign to Spanish tradition. The majority of these ideas, we have noted, came through France. In the light of these new ideas, Spanish life seemed backward and insufficient. The writings of Descartes, Newton, Locke, the ideas of modern science -- these constituted a world more or less well known for the Spanish intellectual. Through the writings of the philosophes as expressed in the French Encyclopedia and elsewhere, some Spanish thinkers were able to perceive all that Spain had not done, and all, it was thought, she had yet to do in order to associate herself with the ideological and material pro-
gress of the continent. The fact that Spain felt left out of the important intellectual currents of the Enlightenment and deficient in the new sciences is very important, for this Spanish feeling of inferiority gives Enlightenment thought in Spain a particular character it lacked in other European nations. In Spain, the Enlightenment was above all a critical movement. Sarrailh sums up the entire eighteenth century by saying it represented "un ferviente deseo de modificar la vida material y espiritual de España." This critical movement motivated a strict examination of national conscience. What was responsible for Spain's backwardness? How could Spain embrace the new ideas sweeping Europe and yet remain true to her own unique national heritage? How could she reconcile the new, often antireligious thought and her own fervent Catholicism? These were the questions asked by men like Feijóo, Cadalso, Jovellanos and the other intellectual leaders who sought to enlighten and reform Spain.

Thus the Enlightenment in Spain was essentially a self-critical movement directed towards reform. And in Spain, as in other European nations, reform was associated with the power of absolute monarchy. The eighteenth century was characterized by an almost universal growth in power of the national states. Monarchs had more direct control over the lives of their subjects than ever before. Some of these rulers were inspired to make use of their personal powers to reform their countries. Like the philosophes, these leaders had assimilated the spirit of experimental rationalism and optimism regarding the future of mankind. These "enlightened despots" supported scientific research to
improve agriculture and manufacture in the belief that they could lead their countries in the building of the better world Francis Bacon had prophesied a century before.

In Spain the advent of "enlightened despotism" was associated with the ascendancy of the House of Bourbon to the Spanish throne. After the "Golden Age" of the sixteenth century had passed its zenith, Spain entered a period of decadence. The tremendous output of energy which produced the great literary works and conquered the New World seemed to have left the nation exhausted — economically, politically, and culturally. In 1700, after the death of Carlos III, the Spanish monarchy passed to Felipe V, the grandson of Louis XIV of France, but his ascendancy to the throne was accomplished only after "la guerra de sucesión" which lasted thirteen years and left the country politically divided and economically debilitated. During the reign of Felipe V the old Spanish empire in Europe began to crumble. In the "paz de Utrecht" (1713) and the "paz de Rastadt" (1714), Spain lost Sicilia, Cerdena, Milan, Luxemburgo, el Franco Condado, Gibraltar and Menorca. The reigns of the later Bourbon rulers (Fernando VI, Carlos III, Carlos IV), although they were highly beneficial to Spain in her internal affairs, were disastrous on the international scene. The "Pactos de Familia" of 1733, 1743 and 1761 formed alliances between the Bourbon monarchs which left Spain subordinated to French political power. Spain's international affairs were further complicated by intermittent wars with both England and France, and the eighteenth century closed with the last of the Bourbon monarchs, Carlos IV, capitulating
to Napoleon and Napoleon's brother, Jose I, occupying the Spanish throne. The Spaniards took to arms in the War of Independence to unseat the ruler they considered to be a usurper, and many of the American colonies took advantage of Spain's involvement with the French to obtain their own independence, thus further weakening the mother country.

In terms of foreign affairs, the Bourbon reign would seem to have been a dismal failure, but in terms of internal, domestic affairs, Bourbon rule was immeasurably beneficial. For the Bourbon kings brought with them to Spain the new ideas of Enlightened Europe. They, and the foreign ministers who often accompanied them, led Spain out of the isolation imposed by Felipe II and put her in contact with the main currents of European scientific and philosophic ideas. This new international spirit began under Felipe V whose ministers included the Italian Alberoni and the French minister Orry who began economic and administrative reforms which other Spanish ministers would continue. Felipe V also began stimulating interest in the new sciences, and organizing various scientific expeditions to the New World.

The new interest in science continued during the rule of Fernando VI (1746-59) when it found its most fervent advocate in the Benedictine monk fray Benito Jeronimo Feijóo, author of the famous Teatro crítico universal. What Spain needed, Feijóo said, was progress in science. He maintained that modern science did not necessarily clash with religion, and asserted that the Aristotelian domination of Spanish education could be broken without harm to the Catholic faith. Feijóo
admired Descartes and Newton, and described their scientific discoveries to his countrymen. But his special hero was Francis Bacon, who, like Feijóo himself, had denied the authority of Aristotle. Until this time, Bacon had enjoyed little favor in Spain and his writings had been dismissed as heretical. Feijóo, however, dared to challenge the Spanish scholastics, asserting that the experimental method of the English Protestant provided a surer means of achieving truth than did scholastic speculation.

Experiment in sciences and skepticism of authority were, then, the lessons Feijóo preached to his countrymen. Of all of the modern sciences, Feijóo particularly encouraged medicine and before his death he had the satisfaction of finding his modern attitude adopted by some advanced doctors in Spain:

From their own readings in recent foreign medical treatises, ...these men began to question Hippocrates and Galen and to seek new cures by experimentation. Many of their ideas have since been shown to be crudely mistaken, but their daring brought fresh life to Spanish science. Of these men, the most capable was Andrés Piquer, who taught at the university of Valencia in the middle of the century, became familiar with the recent discoveries of leading Dutch doctors, and produced an original Tratado de calenturas in 1751, which was later translated into French. His interests had already led him to transcribe for Spanish readers the philosophy of Descartes in a work entitled Lógica Moderna. Like Feijóo, Piquer upheld controlled experiment and observation as the basis for the improvement of the medical science.14

Herr notes that
At the zenith of the activity of Feijóo and Piquer, the imagination of Spaniards began to be excited by the discoveries being made abroad in other sciences. Works of popularizers, addressed to readers who lacked scientific training, came forth to whet the interest of the Spanish public.¹⁵

These works included the Spanish translations of Pluche's *Spectacle de la nature* (1732) and Jean-Antoine Nollet's *Essai sur l'electricité des corps* (1746). In the 1770's extracts or résumés of the works of both Linnaeus and the Frenchman the Comte de Buffon, author of the *Histoire naturelle*, were published in Spain.

The government of Fernando VI, perhaps partly due to Feijóo's influence, continued the support of science Felipe V had initiated:

In 1761, a favorite student of Linnaeus was brought to Spain to improve its botanical studies. Thereafter other foreigners were invited to direct various scientific projects, royal support was given to Spanish specialists in physics and the natural sciences (some of whom achieved well deserved international reputations), promising youths studied abroad often with government support, and foreign and Spanish scientists went to the new world at royal expense to carry on research in natural history and astronomy.¹⁶

The Church and the Inquisition were the only institutions to actively oppose this outpouring of scientific interest and activity, and their opposition constituted the chief obstacle in the path of the new sciences. The Church tried to combat the new learning for obvious reasons. Firstly, the strengthening of secular governmental authority under the enlightened despots threatened Papal supremacy. Secondly, the new currents of thought challenged the authority of Aristotle and thus indirectly attacked the authority of St. Thomas and the entire
scholastic educational structure of the Spanish universities which remained largely in the hands of the clergy. Thirdly, as we have seen, much of the new scientific learning acquired a markedly anti-religious coloring as it passed through the hands of the French Encyclopedists. The Catholic Church could hardly be expected to welcome the writings of men who dismissed God as a needless hypothesis. In order to combat this heresy, the Church placed the French Encyclopedia on its Index of forbidden works in 1759 and most of the other works which had any faintly anti-religious overtones suffered similar fates. But even the power of the Church and its Inquisition could not stop the spread of new knowledge. The above mentioned writings of individual scientists which were allowed to circulate in Spain helped to bring Spaniards abreast of foreign advances in science and technique. And in spite of the ban on the Encyclopedia, public organizations in Barcelona, Madrid, and the Basque provinces managed to acquire its volumes. Thus the Encyclopedia was available to a select group of Spanish intellectuals. Other scientific works too later found their way into Spain. In 1775 Alexandre Savérien's history of science was translated into Spanish, and after 1780 the royal government gave hesitant permission for the publication of a Spanish translation of the second French encyclopedia, the Encyclopédie méthodique of the French publisher, C.J. Panckoucke. Thus, in spite of Church opposition, the Enlightenment continued to gain ground throughout the reigns of the early Bourbons until it reached a peak of popular acceptance during the rule of the greatest of the "enlightened
Under Carlos III scientific activity of all kinds was encouraged and flourished:

...se habían abierto paso hombres eminentes entregados al conocimiento científico de la realidad. Habían irrumpido a su lado también los técnicos afanosos de aplicar la ciencia para obtener de ella utilidades inmediatas. Los estímulos científicos y literarios en España, al mediar el siglo, nos los describe el P. Sarmiento en un pasaje suyo poco conocido pero muy expresivo: <<Hierve la Corte de proyectos literarios. Por docenas se entablan academias para todo género de ciencias y artes ... El ministerio gasta grandes sumas en enviar varios sujetos hábiles a Roma, París, Londres, Venecia, etc., para que cada uno se instruya mejor en su facultativa profesión y que, de vuelta, la puedan enseñar en España. Cirujanos, médicos, boticarios, arquitectos, botánicos, pintores, etcétera, todos hallan en el Rey un protector. Dentro de España, unos salieron a registrar minas, otras plantas, otros canteras, etc.>>

In addition to encouraging scientific activity, Carlos III attempted a radical reform of the educational system. This reform was necessary because, as Sarrailh notes:

[la España ilustrada de la segunda mitad del siglo XVIII]... cree en la cultura como fuente de la felicidad individual y nacional, pero en una cultura práctica, útil que el gobierno ha de proteger y dirigir. De este primer principio nace una primera necesidad: la de reformar y organizar la enseñanza.

The other Bourbon rulers had spoken of the need for educational reform and had made some minor changes but:

Hasta el siglo XVIII, en general, los documentos sobre los males se contentan con señalar, en tono mediocre, ciertas deficiencias que pudieramos considerar externas. Las soluciones propuestas y las medidas de cor-
Palacio Atard describes the two principle weaknesses of the university system at the time of Carlos III as firstly:

La formación de una casta, con los colegiales mayores, que retuvo en sus manos las cátedras, las becas y los puestos todos de acceso a la ciencia o del cultivo de la misma en la universidad.

and secondly:

La cátedra fue utilizada no como un fin en sí misma, para el servicio y la entrega a la ciencia, sino como un medio o instrumento para hacer carrera administrativa, para alcanzar "plaza", como se decía entonces, o empleo en los buenos puestos de la administración del Estado o de la Iglesia.

In order to correct these two deficiencies, Carlos III attempted to reform the "colegios," aiming his reforms specifically at breaking their closed "caste system," and to changing the administration of the "cátedras" or professorships. Carlos III began his reform of the cátedras by expelling the Jesuits, who held most of these teaching positions, in 1776. The expulsion of the Jesuits cleared the way for the entrance of "new blood" into the educational system as well as conveniently disposing of the principal ultramontane interest group which, of course, opposed the absolute authority of the monarchy which Carlos III sought to safeguard.

In the long run, the reforms attempted by Carlos III were largely unsuccessful and the universities quickly reverted to their former ordering. Palacio Atard feels that the "abandono científico en la
España moderna" can be attributed to the failure of these reforms. But Carlos' reform movement was nevertheless significant, because it focused attention on education, and gave impetus to the idea that education held the key to progress, an idea which we will see carrying over into the nineteenth century. If the educational system could be perfected, it was felt that sciences and learning would flower and Spain would reap material and economic benefits as well as regain much of her lost international prestige. Thus educational reform had an essentially utilitarian purpose.

This utilitarian aim was shared by most of the reforms:

La mentalidad burguesa y el estilo moderno de pensamiento, con su libre crítica racional, se plasman en el <<afán de reformas>> tan característico de la segunda mitad del siglo XVIII español. Este afán de reformas, si lo analizamos cuidadosamente, parece polarizarse en el intento de rectificar de modo radical el ordenamiento económico del país. Creo que puede concretarse aun más la afirmación: el afán de reformas consiste, a fin de cuentas, en procurar un nuevo ordenamiento económico, y a él se subordina incluso la reforma cultural, puesto que las disposiciones nuevas introducidas en este campo están enderezadas a conseguir la remoción del orden económico vigente, lo que traerá a España, con las luces del mundo moderno, la abundancia de medios materiales, la prosperidad y la felicidad de los españoles sobre la tierra, meta última de aquel movimiento intelectual y político.23

To summarize, the eighteenth century Enlightenment movement in Spain was characterized by a critical attitude and a desire to modify both the material and spiritual life of the nation. To achieve this end, the enlightened monarchs encouraged the spread of scientific
knowledge and reform of the educational system as ways to improve the national economy and the national image abroad. At the same time, the Church and other conservative elements within the country opposed the entrance of enlightened ideas partly because these ideas represented a threat to their own power and authority, partly because they felt many of these ideas to be heretical and dangerous to the Catholic faith. During the reign of Carlos III, these rival factions of enlightenment and conservative opposition were held in balance, although after his death the division between these two groups was to widen. We see this intellectual climate of midcentury reflected in the Cartas Marruecas of José Cadalso, one of the principal advocates of reform at the time of Carlos III.

C) CARTAS MARRUECAS OF JOSE CADALSO (1741-1782)

José Cadalso was born in Cadiz where he began his studies with the Jesuits. He later completed his education at the Seminario de Nobles in Madrid, and supplemented this basic education by traveling widely through various European countries, learning several languages. At the age of twenty-one he began a brilliant and dedicated military career which he pursued until his death on the battlefield in 1782 during the siege of Gibraltar. His various journeys abroad gave him the cosmopolitan outlook typical of the most enlightened Spaniards of the mid eighteenth century and made him aware of the backwardness of his own country in comparison to the other nations of Europe.
But Cadalso never lost his essential "españolismo." Fiercely patriotic and dedicated to his own country, Cadalso focused all of his accumulated knowledge and brought it to bear on the problem of Spain. Like Feijóo, Jovellanos, and the other major figures of the reform movement, the enlightenment caused Cadalso to look closely at the character of his country in order to find, within the national character, the reasons for Spain's present decadence. Cadalso's meditations on Spain are found principally in his Cartas Marruecas (1789). Although in Cartas Marruecas Cadalso touches on almost all aspects of contemporary Spanish life — its customs, its government, its economy, etc. — in this dissertation we will be concerned only with the attitude towards the new sciences that he expresses. For Cadalso's attitude toward science can be said to typify eighteenth-century Spain's reaction to the Scientific Revolution.

The full title of Cartas Marruecas explains the nature of the book: Cartas escritas por un moro llamando Gazel Ben-Aly, a Ben-Beley, amigo suyo, sobre los usos y costumbres de los españoles antiguos y modernos con algunas respuestas de Ben-Beley, y otras cartas relativas a éstas. The work is thus a collection of letters written by the two Moors, Gazel and Ben-Beley. There is no "plot;" the letters which comprise the work merely record the impressions that Spain makes on the young Moor, Gazel, who is visiting the country for the first time. Nuño, a Spaniard, acts as his mentor and guide in Spain. Nuño serves to correct any false impressions Gazel may form as a result of his ignorance of national customs. Many critics have
felt that Nuño also acts as the "personaje vocero" of the work, expressing the opinions of Cadalso himself. For Nuño, like Cadalso, is a loyal and patriotic Spaniard and praises his country to Gazel for that which is of value in her tradition, yet recognizes her present weakness and criticizes her faults. Most of the letters are written by Gazel to his old friend and teacher, Ben-Beley, who remains in Morocco. The technique of using a foreign traveler's impressions of an unfamiliar country as a vehicle for social criticism had been used by other eighteenth-century authors, notably by Montesquieu, and had proven to be highly effective. Thus in writing the Cartas Marruecas, Cadalso is drawing on an established literary tradition.

In the Introduction, Cadalso explains the nature of the work:

> Estas cartas tratan del carácter nacional, cual lo es en el día, y cual lo ha sido.

and explains his relationship to the manuscript he is publishing:

> Yo no soy más que un hombre de bien, que he dado a luz un papel, que me ha parecido muy imparcial, sobre el asunto mas delicado que hay en el mundo, que es la crítica de una nación (p. 11).

In addition to denying his own authorship of the work, Cadalso here emphasizes the fact that the letters contain a criticism of Spain—a criticism which, since it was written by a foreigner who could be expected to be more objective in his judgements than a native Spaniard, is fair and impartial.

The subject of Spain and the new sciences appears early in the work (Carta IV). The early appearance of this topic and frequent later references to it emphasize the important position this topic
occupied in Cadalso's critical thought. The first reference establishes the decadence of present-day Spain in the sciences:

¿Hablas de ciencias? En el siglo antepasado tu nación era la más docta de Europa, como la francesa en el pasado, y la inglesa en el actual; pero hoy, al otro lado de los Pirineos apenas se conocen los sabios que así se llaman por acá (p. 21).

Once Cadalso has established Spain's decadence, he proceeds in the following letters to discuss the causes of her decline.

He first cites the lack of support given to those who would teach sciences:

El atraso de las ciencias en España en este siglo, ¿quién puede dudar que proceda de la falta de protección que hallan sus profesores? Hay cochero en Madrid que gana trescientos duros, y cocinero que funda mayorazgo; pero no hay quien no sepa que se ha de morir de hambre como se entregue a las ciencias, exceptuadas las de pánico lucrando, que son las únicas que dan de comer.

Los pocos que cultivan las otras son como los aventureros de los ejércitos, que se llevan paga y se exponen más. Es un gusto oírles hablar de matemáticas, física moderna, historia natural, derecho de gentes, antigüedades y letras humanas, a veces con más recato que si hiciessen moneda falsa. Viven en la oscuridad y mueren como vivieron, tenidos por sabios superficiales en el concepto de los que saben poner setenta y siete silogismos seguidos sobre si los cielos son fluidos o sólidos (p. 23).

Spain's lack of progress in the sciences can then be attributed to the fact that she does not support those who attempt to spread the new knowledge of the seventeenth century, but instead prefers to reward the traditional scholastic educators, who continue to perpetuate an outworn system based on useless syllogistic logic chopping
and "saben poner setenta y siete silogismos sobre si los cielos son fluidos o sólidos." For Cadalso, this adherence to scholasticism constitutes the second main cause for the decadence of Spanish science.

Cadalso believes the outworn scholastic philosophy has been maintained in Spain because of a mistaken and damaging adherence to tradition:

La Filosofía aristotélica con todas sus sutilezas, desterradas ya de toda Europa, y que sólo ha hallado asilo en este rincón de ella, se defiende por algunos de nuestros viejos con tanto esmero e íba a decir con tanta fe como un símbolo de la religión. ¿por qué? Porque dicen que es doctrina siempre defendida en España, y que el abandonarla es desdorar la memoria de nuestros abuelos (p. 52).

In Carta LXXVIII Cadalso describes "un verdadero sabio escolástico." The portrait that emerges is that of a pseudo-intellectual, a man who considers himself learned because he knows a smattering of rhetoric and poetry, yet who reveals his ignorance at every step by referring to modern physics as "un juego de títeres," and to modern mathematics as "embuste y pasatiempo."

The domination of the scholastics results in a defective educational system that produces the ignorant and pedantic "disputadores," "proyectistas," and "caballeros" Gazel describes in Cartas XXIII, XXXIV, and VII respectively. The "disputadores," are "hombres que tienen por oficio el disputar." These men show off their skills in public at meetings known as "conclusiones." Gazel attends one of these affairs and writes the following account to Ben-Beley:
Uno de ellos [los disputadores]... defendió por la mañana que una cosa era negra, y a la tarde que era blanca. Lo celegré infinito, pareciéndome esto un efecto de docilidad poco común entre los sabios; pero desenganéme, cuando vi que los mismos que por la mañana se habían opuesto con todo su brío, que no era corto, a que tal cosa fuese negra, se oponían igualmente por la tarde a que la misma fuese blanca. Y un hombre grave, que se sentó a mi lado, me dijo que esto se llamaba defender una cosa problemáticamente.... (p. 55).

This display of scholastic pedantry is too much for poor Gazel and he confesses:

Nada entendí de todo esto. No puedo comprender qué utilidad pueda sacarse de disputar setenta años una misma cosa sin el gusto, ni aun siquiera la esperanza de aclararla (p. 55).

Gazel next writes of an encounter with the "proyectistas" -- "los innovadores de profesión." Nuño is speaking to one of these men about the present decline of the arts and sciences in Spain. The "proyectista" interrupts him to describe a wild scheme to divide Spain by means of a series of canals. He seems to feel that this system of canals will provide the answer to all of Spain's problems. Nuño finally stops the "proyectistas" mad discourse and comments simply to Gazel:

¿Sabes lo malo de esto? ... Lo malo es que la gente, desazonada con tanto proyecto frívolo, se preocupa contra las innovaciones útiles, y que éstas admitidas con repugnancia, no surten los buenos efectos que producirían si hallasen los ánimos más sosegados (p. 72).

But perhaps the most damning indictment of bad education occurs in Gazel's description of the young "caballero" in Carta VII. Gazel first comments that in Morocco there are no social classes; all men
are equal. But in Spain, and in all of Europe, there are three main social classes. Gazel feels this class distinction demands an especially sound educational system:

...en Europa la educación de la juventud debe mirarse como objeto de la mayor importancia. El que nace en la ínfima clase de las tres, ...no necesita estódiros, sino saber el oficio de sus padres en los términos en que se lo ve ejecutar. El de la segunda ya necesita otra educación para desempeñar los empleos que ha de ocupar con el tiempo. Los de primera se ven precisados a esto mismo con más fuerte obligación, porque a los veinticinco años, o antes, han de gobernar sus estados,...disponer de inmensas rentas, mandar cuerpos militares, concurrir con los embajadores, frequentar el palacio, y ser el dechado de los de la segunda clase. (p. 26).

But this theory is seldom adhered to in practice. To illustrate, Gazel describes Nuño's encounter with a young Spanish caballero. Nuño meets the young man while traveling through the mountains on his way to Cadiz. Since it is near nightfall, the young noble invites Nuño to spend the night at his Grandfather's house. While they travel, Nuño reports:

La conversación cayó según costumbre sobre el tiempo y cosas semejantes; pero en ella manifestaba el mozo una luz natural clarísima, con varias salidas de viveza y feliz penetración, lo cual, junto con una voz muy agradable y gesto muy proporcionado, mostraba en él todos los requisitos naturales de un perfecto orador; pero de los artificiales, esto es, de los que se enseña el arte por medio del estudio, no se hallaba ni uno siquiera (p. 27).

But as they continue, Nuño finds that his companion cannot answer a single one of the specific questions he asks, for the young man always answers merely "¿Qué se yo de eso?" and then tells Nuño he
should ask so-and-so who is an "expert" in that field. Nuño's curiosity is aroused, and he asks the caballero how he had been educated and he replies:

A mi gusto, al de mi madre y al de mi abuelo, que era un señor muy anciano que me quería como a las niñas de sus ojos.... mi padre bien quería que yo estudiase, pero tuvo poca vida y autoridad para conseguirla. murió sin tener el gusto de verme escribir (p. 28).

The pair arrives at the grandfather's house where a group of various friends and relatives has gathered for a hunt on the following day and is passing the night gambling, drinking, singing and dancing. Here Nuño meets tío Gregorio, the dominant influence in the life of the young caballero:

A su voz ronca y hueca, patilla larga, vientre redondo, modales bastos, frecuentes juramentos y trato familiar se distinguía entre todos. Su oficio era hacer cigarros, dañándolos ya encendidos de su boca a los caballeritos, atizar los velones, decir el nombre y mérito de cada gitana, llevar el compás con las palmas de las manos cuando bailaba alguno de sus apasionados protectores, y brindar a su salud con medios cántaros de vino (p. 29).

The uproar continues through the night, and Nuño is unable to sleep. At dawn, as he is preparing to leave, he says to himself: "¿Así se cria una juventud que pudiera ser tan útil si fuera la educación igual al talento?" With this question Cadalso frames his most powerful indictment of the Spanish education.

A common idea seems to underlie Cadalso's criticism of all of these figures. For in Gazel's comments on each of them, Cadalso emphasizes their lack of utility to society. In reference to the
disputadores, he says "No puedo comprender qué utilidad pueda sacarse de disputar setenta años una misma cosa...sin la esperanza de aclararla." The proyectista is censored not only because his schemes are themselves frivolous and useless, but also because they turn the people against "las innovaciones útiles." And finally, in the sketch of the young caballero, Cadalso laments the mismanagement of the education of the young "que pudiera ser tan útil si la educación fuera igual al talento." Clearly Cadalso believes in education not merely for its own sake, but for its utility to society. To secure this utility, reform is needed.

Cadalso makes his most explicit statement about the nature of the educational reform he envisions in Carta LXXVIII. After describing the "Verdadero sabio escolástico," the obvious question arises: "¿Cómo hemos de vivir con estas gentes?" And Núñez replies:

Muy fácilmente ... Dejemoslos gritar continuamente sobre la famosa cuestión que propone un sátiro moderno, utrum chimera, bombilians in vacuo, possit comedere secundas intentiones; trabajemos nosotros en las ciencias positivas para que no nos llamen bárbaros los extranjeros; haga nuestra juventud los progresos que pueda; procure dar obras al público sobre materias útiles; déjemos morir a los viejos como han vivido, y cuando los que ahora son mozos lleguen a edad madura, podrán enseñar públicamente lo que ahora aprenden ocultos. Dentro de veinte años se ha de haber mudado todo el sistema científico de España insensiblemente, sin estrépito, y entonces verán las academias extranjeras si tienen motivo para tratarnos con desprecio (p. 143).

Thus Cadalso advocates the study of the new sciences, but he clearly supports science for utilitarian ends -- he favors the study of
science because it would firstly increase Spain's international prestige ("para que no nos llamen bárbaros los extranjeros") and secondly because it would aid Spain materially, and, we would suppose, economically. And so we see in Cadalso the utilitarian aim we have noted as being characteristic of most of the reformers and realize again that the enlightened thinkers of eighteenth-century Spain regarded the spread of scientific knowledge and the reform of the educational system principally as ways to improve the national image and the national economy.

But how firm is Cadalso's commitment to the new sciences aside from their utilitarian value? Does he advocate complete acceptance of them, complete national reform under the direction of science and reason? The answer is of course most definitely, no.

Cadalso proposes no essential modification in the life of his country. He is willing to accept the products of reason, the 'innovaciones útiles,' but he would place one irremovable restriction upon innovations in general. The acceptable innovations must deal only with that which he terms 'lo accidental,' the external and in no way essential aspects of Spanish life. They must not impinge upon the 'raíces,' that which is of real importance to the author and which he calls 'lo esencial.'

The most important ingredient in "lo esencial" of Spanish tradition is, for Cadalso, the Catholic faith, and he zealously defends it from any attack by the new thinking. His treatment of the Legend of Santiago in Carta LXXXVII provides an excellent example of this defense. Gazel has asked Nuño if he believes it is true that the Apostle Santiago descended from heaven to aid the Spanish forces
fighting against the Moors at the battle of Clavijo. Nuño, while admitting that this epoch of history belongs to the distant past and its legends therefore cannot be accepted as "artfculos de fe," nevertheless defends the Legend of Santiago. And he defends it on the grounds of its utility:

...la creencia de que baja un campeón celeste a auxiliar a una tropa, la llena de un vigor inimitable... los que pretenden disuadir al pueblo de muchas cosas que cree buenamente, de cuya creencia resultan efectos útiles al estado, no se hacen cargo de lo que sucedería si el vulgo se metiese a filósofo y quisiera indagar la razón de cada establecimiento (p. 156).

Nuño then speaks of his disapproval of "la secta hoy reinante que quiere revocar en duda cuanto hasta ahora se ha tenido por más evidente que una demostración de Geometría." The men of this sect (Cadalso is probably referring to the French "philosophes") deny the authority of religious tradition and revelation — what Cadalso refers to as "los cimientos de la misma religión" — and even go so far as to deny the existence of an afterlife. Nuño says his answer to them would be:

...aunque supongamos por un minuto que lo que decís fuese cierto, ¿os parece conveniente publicarlo y que todos lo sepan? La libertad que pretendéis gozar, no sólo vosotros mismos, sino esparcir por todo el orbe, ¿no sería modo más corto de hundir al mundo en un caos moral espantoso, en que se aniquilasen todo el gobierno, economía y sociedad? Figuraos que todos los hombres persuadidos por vuestros discursos no esperan ni temen estado alguno futuro, después de esta vida; en qué creéis que la emplearán? En todo género de delitos, por atroces y perjudiciales que sean (p. 156).
Here it seems we have an essentially conservative man trying to use the new rationalism to his own advantage. Cadalso believes the teachings of the faith to be true, but even if they were not true, he reasons, they should be upheld for their utility. As John B. Hughes notes:

He is in the situation of a man of faith attempting to prove something which he chooses to believe rather than suffer the consequences of disbelief.28

Cadalso then is not content with the honor of being called "bárbaros" by the heretics of the continent. He would have his countrymen learn the discoveries of modern science "para que no nos llamen bárbaros los extranjeros." He wants to equalize the condition of Spain with reference to England and France, thus admitting the importance of the scientific discoveries of these countries.

Cadalso would imitate Europe and learn from her the things that Spain is lacking in order to change certain aspects of "lo accidental" in Spanish life. He supports the adoption of those European "innovaciones útiles" which would benefit Spain. But he would permit the entrance of only those innovations which have been carefully screened. His remarks on the translation of foreign works into Spanish reveal that he would protect Spain from being contaminated by Europe. He concludes: "y a la verdad, preciendo de lo que han adelantado en física y matemática, por lo demás no hacen absolutamente falta de traducciones."

Cadalso's approach to the problem of Spain is hardly a rational analysis. As Hughes points out:
...his intellectual and emotional process could better be described as an intuitive-rational response. This 'intuitive-rational' perspective is a unique personal blend in which the rational analytical approach common to Eighteenth Century thinkers is applied to a series of first principles, (his view of the world, God, man, Spain and Europe), derived not through reason but based either upon an acceptance of transcendental revelation or upon the total immanent demands of his own life.29

It is his essentially intuitive approach and his conservativism that separate Cadalso from the "philosophes" of the French Enlightenment. Far from being a radical who would remake the basic structure of Spanish life, Cadalso appears to us from the pages of Cartas Marruecas as a conservative patriot who would not change one iota of the fundamental preconceptions of his countrymen, and whose formula for national salvation is simply on the one hand to graft onto the "venerable tronco" of Spanish life certain "innovaciones útiles" of foreign origin and on the other hand to return to the principles of the "true Spain" as incarnated in the Catholic Soverigns.

D) THE CONSERVATIVE REACTION AT THE END OF THE CENTURY

As we have seen, during the reign of Carlloss III the new ideas of the enlightenment reached a high point of public acceptance. There was conservative opposition to the new thought, but in general the cohesive force of the Enlightened despotism prevailed over the tensions existing between enlightened liberals and conservatives, and the two forces maintained an uneasy equilibrium. It is this state of
compromise between the new and the traditional which we see reflected in Cadalso's *Cartas Marruecas.* But this equilibrium was destroyed after Carlos III's death. As Herr puts it:

> The ideal of enlightened despotism was shattered in the first decade of Carlos IV's reign...only then did tensions in Spanish society outpull cohesive forces.

The chief factor in the destruction of the balance achieved between the conservative and the new ideas was the French Revolution. For the French Revolution showed the logical consequences of the new ideas -- the abolition of the established monarchy, the destruction of the faith, government in the hands of heretics and anarchists -- and the Spanish conservative mind recoiled in horror. The shock waves of the revolution caused a violent conservative reaction in Spain. Even the most fervid reformers were somewhat shaken in their confidence in the ideas of the enlightenment, and the enemies of the new thought reacted against any innovations with renewed violence.

Toward the end of the century there was, as Herr notes, a considerable revival of enlightenment ideas under Godoy, Carlos IV's first minister, but the tone of the enlightenment was greatly changed. The revulsion Spaniards felt towards the French Revolution was extended to all of the new thought contained in the French *Encyclopedia.* For Spain attributed the horrors of the French Revolution to the heretical teachings of Voltaire and the *philosophes.* Since the new sciences had mainly been transmitted to Spain through the *Encyclopedia,* they too suffered a loss of prestige. In order to save any of the new sciences from what Herr refers to as "the universal opprobrium
being heaped on modern philosophy," the defenders of sciences had to redefine their position:

In 1788 they [the defenders of the new sciences] had favored 'modern philosophy,' and it was evident that what they had in mind was experimental science; for the anti-religious aspect of French philosophie had not penetrated Spain. ... Now, in order to defend experimental science, which to them was still 'modern philosophy' -- after all its only place in the university curricula was in the reformed philosophy courses -- they had to draw a line between this, the 'new Christian philosophy,' and the 'false philosophy' of Voltaire and Le systeme de la nature.31

Through this redefinition, most of the scientific teachings of Bacon, Descartes and Newton were salvaged. Once their thought was separated from that of Voltaire and the French Encyclopedists who spread their teachings, it proved quite acceptable to Spanish minds, for these scientists had themselves never regarded science as being in conflict with religion, but rather as supporting it.

Thus, throughout the course of the eighteenth century the Enlightenment carried the new scientific ideas into Spain. Even the conservative reaction at the end of the century could not completely stop the advance of the new sciences. One of Jovellanos' speeches, delivered in 1794 at the opening of the Real Instituto Asturiano in Gijon illustrates the progress science had made by the end of the century. Jovellanos contends that the knowledge best able to produce private and public wealth is the practical knowledge derived from the study of nature. He attacks the authority of Aristotle and defends instead Descartes and Newton, insisting that their methods provide the
best means of studying nature, "the book that Providence laid open to men for their study." 32

In brief summary, the eighteenth century Enlightenment movement brought the discoveries of the scientific revolution into Spain. Spain's attitude toward the new sciences is, as we have seen in the Cartas Marruecas, rather contradictory. On the one hand, Spain, in her decline, welcomed science and saw its application as the utilitarian means of achieving economic advances and of rebuilding her international image. Spain was infused with the spirit of optimism which accompanied the birth of modern science under Bacon. Science seemed to be the key to progress. By studying nature, man could learn her secrets and in so doing reap material benefits and improve his society. In order to enjoy the fruits of science, it seemed only necessary to reform the educational system to accommodate the study of this discipline. Then, under the guidance of science, society would learn the way to utopia. Yet in spite of this optimism, Spain feared the new sciences. Like Cadalso, most Spaniards sensed that science threatened many of their old traditions, and endangered their religious faith.

It is this dual reaction to science -- optimism on the one hand; pessimism and fear on the other -- that we will see developing further in the next century and continuing to our own times.


10. As quoted by Dampier, Ibid., p. 197.


15. Ibid., p. 42.

16. Ibid., p. 44.


20. Ibid., p. 129.

21. Ibid., p. 133.
22Ibid., p. 127.

23Ibid., pp. 33-34.


25José Cadalso, Cartas Marruecas, p. 11. All future page references are made to the Colección Austral edition; Buenos Aires: Espasa-Calpe, 1952.

26It is interesting to note that Cadalso evaluates his own work in terms of utility. As Herr notes: "The value he assigns to the Cartas Marruecas is one of utility. He is placing the 'verdades útiles' at the service of his country." Herr, op. cit., pp. 39-40.


28Ibid., p. 76.

29Ibid., p. 67.

30Herr, op. cit., p. 444.

31Ibid., p. 352.

32Ibid., p. 355.
CHAPTER III

THE NINETEENTH CENTURY: THE RISE OF THE BIOLOGICAL SCIENCES

In the seventeenth and eighteenth centuries it was astronomy that had the most profound effect on the minds of both philosophers and of ordinary men. Copernicus had dethroned the earth from its ancient position as the center of the universe and Galileo and Newton had proven that the heavenly bodies were not divine and incorruptible, but rather moved in accordance with purely terrestrial dynamics. These discoveries in astronomy revolutionized man's view of the cosmos.

But by the nineteenth century the changes in world view occasioned by the new astronomy had been largely assimilated and no longer caused problems. Man's world view was, however, soon to be disturbed once more by another revolution in scientific and philosophic thought. This time the revolution was to come not from astronomy or the physical sciences, but from the biological sciences. Standing at the center of this new scientific revolution was Charles Darwin whose theory of evolution transformed the thought of the nineteenth century in much the same way Newton's theory of gravitation had transformed that of the seventeenth.

We have said that there was little scientific progress in the eighteenth century because at that time no discipline except
astronomy had a long enough history of orderly observations to enable men to form the bold hypotheses of the Newtonian type which produce the giant steps in the history of science. But throughout the eighteenth century men made careful observations of nature. Linnaeus observed and classified the multitudes of different plant and animal species. Other men like Buffon, Kant and Laplace studied the earth's crust and attempted to formulate theories for the origin of the earth and solar system. Although most of these theories were largely speculative and have since been disproved, they represent important steps in the history of science because for the first time they attempted to explain historical changes in the condition of the earth's crust in terms not of divine but of natural causes.

Paleontology, or the study of fossils, had begun in the seventeenth century and progressed steadily in the eighteenth. This discipline combined with the study of geology to give evidence for both the immensity of geological time and the slowness of geological changes, theories which were both well established by the close of the eighteenth century. By the end of the century the fossil record had also established another crucial fact: many fossils represented species which were completely unknown at that time, leading to the theory that certain prehistoric species had suffered extinction.

In addition to the evidence for the former existence of species now extinct, the study of paleontology and geology unfolded a vast history of changes on land and sea. Fossils of marine animals were constantly being discovered in land strata, giving tell-tale indica-
tions of prehistoric changes in land and sea.

Now the time was ripe for the formation of the critical hypothesis:

Given the universal adaptation of animals and plants to the conditions of their habitat — which had been remarked by all naturalists since the time of Aristotle — and given the almost infinite variety of conditions that nature had at her disposal, might we not jump to the conclusion that the species themselves had followed a process of development paralleling the changes of natural conditions?

The great French popularizer of science, George Louis Leclerc, Comte de Buffon, actually reached this conclusion towards the middle of the eighteenth century, but Buffon failed both to state the theory with any scientific precision and to produce evidence in its support. In 1794 Erasmus Darwin, the grandfather of Charles, attempted to further elaborate on Buffon's hypothesis, but he too failed to make any significant contribution because like Buffon he was unable to establish a mechanism which might act as the cause of the evolution he intuitively sensed to be operating in nature.

The only early figure in the formulation of the evolution hypothesis who was able to produce a theory of a mechanism which would account for the evolutionary process was Lamarck. The Lamarkian theory of evolution may be described as a theory of "use and disuse" or "inheritance of acquired characteristics." There are basically two ways in which an organism may come to differ from other organisms of the same species: it may, for no apparent reason, be different at birth; or it may become different during its lifetime by the
habitual exercise of some organ or faculty -- thus a carpenter could
develop an unusually strong arm or a blind man an extraordinary sense
of touch. Differences which arise at birth are called "spontaneous
variations," while differences arising from habit are referred to as
"acquired characteristics." Lamarck believed that acquired character­
istics could be inherited and felt that the inheritance of such charac­
teristics acted as the main cause of evolutionary change. In his
view, individual creatures made conscious efforts to adapt themselves
to their environment. The results of these efforts were inherited
and improved the succeeding generation. For example, giraffes con­
tinually streached their necks in order to reach for high foliage,
and each generation passed on its slightly greater length of neck to
the next.

According to Lamarck's theory of use and disuse the permanent
disuse of an organ, arising from a change in habits, would cause the
gradual shrinkage and ultimate disappearance of that organ. On the
other hand, the frequent use of any organ, when confirmed by habit,
would increase the functions of that organ and lead to its increased
development.

The great difficulty with Lamarckian theory is that of defining
precisely how the stimulus of environment leads to the formation of
hereditary characteristics. For it is difficult to see how external
modifications due to exercise or habit could affect a creature's
genetic constitution so that they could be passed on to succeeding
generations. And indeed, experiment since Lamarck's time has proven
that there is no significant inheritance of such modifications.

It remained, therefore, for Charles Darwin to discover the pre-
cise mechanism which would provide the cause for the evolutionary
process.

A) CHARLES DARWIN AND THE THEORY OF EVOLUTION

In order for any theory of evolution to be acceptable it must do
two things: firstly, it must establish the fact of biological evolu-
tion, past and present; and, secondly, it must reveal the causes of
this evolutionary process. Lamarck failed to establish any valid
mechanism of cause and effect and his theories were therefore never
widely accepted. Darwin however was more fortunate, for he was able
to establish the necessary cause and effect relationship. We have
outlined the idea of cause and effect in the first chapter where we
noted that this concept was one of the most important ideas produced
by the scientific revolution and acted as one of the divisions between
medieval and modern scientific thought. Now in the nineteenth century
we see that scientific thought is still dominated by the idea of cause
and effect. Encouraged by the success of Newton's application of
the cause and effect relationship in the discovery of the theory of
gravitation, thinkers came to demand a mechanism of cause and effect
in every science. Darwin was successful not because he invented the
theory of evolution -- that was known to his grandfather -- but because
he established a machinery for evolution: the mechanism of natural
selection. As Bronowski notes:

Darwin saw that evolution is explained if we assume that the environment causes better adapted animals to survive in the competition with their rivals -- the struggle for existence. Once Darwin had proposed this chain of cause and effect, the theory of evolution was accepted by every one...\(^2\)

Darwin's theory represents an attempt to force the principle of evolution into the scientific mold of mechanistic determinism. Natural selection attempts to visualize the mechanical "go" of evolution in the same way that gravitation gives the "go" of the solar system:

Just as Newton took the idea of gravitational attraction and transformed it into an impersonal law of a force that varied inversely as the square of the distance and directly as the product of the masses, so Darwin took the poetic metaphor of the struggle for existence and transformed it into an impersonal cause.\(^3\)

How did Darwin arrive at this crucial theory of natural selection? As a result of his observations of wild animals as naturalist abroad the H.M.S. Beagle, a surveying ship which sailed the coasts of South America, Africa, and Australia from 1832-1836, and of his knowledge of the breeding of domestic animals, Darwin became convinced of the following facts:

1. Spontaneous variations occur in all species of animals.
2. Evolution is rapidly affected among domestic creatures by breeders who take selective advantage of these variations.

Once he reached these conclusions, Darwin's next problem was to prove the existence of an evolution among wild animals that would parallel the evolution produced by selective breeding in domestic animals.
Darwin saw evidence for such evolution in the geological record, the present geographical distribution of animals, the existence of vestigial structures in modern creatures and in the similarity of many of the species. He therefore concluded that variation and evolution do indeed take place in nature. But as Hull notes, Darwin realized that:

... variation alone cannot account for evolution: by itself it would produce the overall stability that goes with random change. There must be some other natural mechanism at work to do what the breeder does with his flocks and herds.

Darwin hit upon this mechanism one day in 1838 while reading a passage in Malthus' *Essay on Population*. The central thesis of Malthus' work was that man being a reproductive animal has a natural tendency to increase in numbers in a geometric proportion -- that is, in a series with the form of 2, 4, 8, 16, 32, 64, etc. But the food supply on which man is dependent could at best increase only in what mathematicians call an arithmetic progression, according to the general form 2, 4, 6, 8, etc. There was, therefore, a constant tendency for human population to increase beyond the food supply. Darwin at once realized that if Malthus' law were applied to plants and animals living under natural conditions, it would provide the long-sought mechanism for evolution. Since populations increase beyond their food supply, there must be competition, a struggle for existence, as all individuals compete to obtain food. If all organisms of a given species were born exactly alike, this competition for food would accomplish nothing except to restrict the numbers. But Darwin had already established the fact of spontaneous variation. And once he
saw the struggle for existence in conjunction with the fundamental fact of variation, he realized that the struggle for existence results in a dynamic selective mechanism. Some of the spontaneous variations which occur in nature would give organisms affected by them a better chance for survival than their fellows, and hence more organisms possessing this variation would live to breed and thus pass this variation on to their descendents. Therefore:

Natural selection will do what the breeder's artificial selection does with domestic creatures. It will take longer; because the breeder breeds exclusively from favored individuals, whereas nature breeds only slightly more from the favored than the unfavored. But in time the effect will be the same, and the character of the race will be modified.  

Darwin had provided the missing link, the mechanism that acted as the cause of the evolutionary process. Now all of his observations aboard the Beagle fitted together and supported his theory of evolution. Yet Darwin waited twenty years, until 1859, to publish this theory in his monumental work the *Origin of the Species*. Presumably, he wanted to be absolutely certain of his conclusions. When his work was published, it was so meticulously documented and his theory so well supported, that it soon came to be accepted as scientific fact. But once accepted, Darwin's theory of evolution, like Newton's earlier theory of gravitation, caused a tremendous upheaval in popular thought and, as we will see, demanded a radical change in world view.
B) THE PHILOSOPHICAL IMPLICATIONS OF EVOLUTION

The nineteenth century saw the development of close ties between science and philosophy. Indeed, two of the most prominent nineteenth-century philosophers -- Comte and Spencer -- define philosophy as a generalization of the results of all the sciences. Moreover, it is generally conceded that it was Herbert Spencer, not Charles Darwin, who made evolution an integral element in the intellectual equipment of every educated man, and introduced the evolutionary formula into every phase of human knowledge in his voluminous *System of Synthetic Philosophy* (1860-1896). Evolutionary theory permeated the thought and work of all of the major nineteenth-century philosophers as they attempted to reconcile philosophy and the new scientific theory. But rather than examine in detail the impact of evolution on the philosophy of particular thinkers, it would perhaps be more profitable for us to examine the general climate of thought the new theory created, to examine the way in which thoughtful men, not exclusively philosophers, reacted to Darwin's *Origin of the Species*. This approach would seem to be more productive for our purposes, for we want to examine the general impact of evolution on literature which, while sometimes influenced directly by particular philosophers, is usually more markedly affected by the entire "weltanschauung" of the times. In the most general terms, it can be said that the idea of evolution generated two different views of the world, one markedly optimistic, the other quite pessimistic.
Many thinkers projected the course of evolution into the future and in so doing found cause for optimism. If, they reasoned, evolution had led from simpler to more complex organisms, and from ape-like precursors to homo sapiens, it was natural to suppose that evolution would continue to mark progress both in natural history and in human morphology and society. The theory of evolution thus seemed to offer a complete scientific confirmation of the eighteenth-century dogma of progress. Evolution:

...gave the notion of progress greater precision. In the past, man had turned primarily to history to get evidence to confirm the doctrine of progress. Now he could have recourse to physical and biological science. Progress no longer seemed merely a matter of opinion. It was regarded as a universal law.7

Furthermore, the demonstration that biologists could control, in part, the course of biological development suggested to sociologists that they might find a way of intelligently guiding and directing social evolution. Thus progress might be consciously controlled, bearing mankind towards higher levels of happiness and well-being.

The fact that evolution destroyed the concept of a special creation was also a source of optimism for many thinkers. The traditional argument for the idea of a special creation of the physical world

...upheld the idea that all our social institutions -- the family, property, the state, law, religion, and morals -- are likewise the product of divine fiat. God revealed to man his decisions about the perfect type of family, religion, law, and so on.8

Once the doctrine of the special creation was overthrown by the
evolutionists, the historians and social scientists were able to demonstrate that every human institution -- religious, economic, political, legal, educational or moral -- had been the product of naturalistic influences. Our social institutions were but the outgrowth of trial, error and accident, controlled by broad evolutionary processes. This recognition of the secular origins of human social institutions stimulated a great deal of social optimism:

If man produced our present defective institutions, he surely may, by the application of more complex knowledge, supplant them with far better ones without offering an affront to God.9

But if projecting the course of evolution into the future resulted in a comforting optimism for some, there were others who preferred the backward glance, and for these thinkers evolution resulted in an extreme pessimism. Newton's gravitational theories had established the concept of mechanism in the physical universe; but until the nineteenth century, men could accept the idea of mechanism in the orbiting of the planets and yet maintain that man possessed a free will which exempted him from the determinism which governed the inanimate world. After Darwin this ambivalent belief was no longer possible. Darwin's theory indicated that man too was part of the world machine. Instead of being created as the special lord of the universe by a loving God, man was now seen to be merely a more complex biochemical entity -- a "colloidal aggregate" -- whose origins could be traced back to primitive animals. His kinship with all of the lower forms of nature was definitely established and the process of
his evolution from these forms could be traced. It seemed there was nothing about human life or behavior that could not be explained according to naturalistic laws and principles. The realization of man's place in the universal machine produced a wave of pessimism, because it strengthened the idea of mechanism which had been growing since Newton. By refusing to acknowledge the existence of the uncaused and unconditional, mechanism deprived man of his birthright of freedom and he was transformed into a machine.

The theory of evolution furnished still other grounds for pessimism. It upset the "argument from design" which maintained that the wonderful interrelation of things was evidence that the universe had been created by a conscious being of infinite capacity. Even Newton was, as we have noted, able to resort to this argument. Evolution, however, was one more piece of evidence in favor of believing that the world was merely an intricate mechanism, running without any fixed purpose. As Dampier comments:

If accepted in its fullest sense, natural selection is the negation of all teleology. There is no end in view: merely a constant haphazard change both of individuals and environment, and sometimes a chance agreement between them, which, for a brief moment, may give some appearance of finality.10

Not only was the idea of purpose destroyed, but many of the more pessimistic thinkers argued that the idea of progress was untenable as well. Such thinkers pointed out that while present evolution may give the illusion of a progression to higher, more intelligent forms, this is not an irreversible process. If the environment were to change
so that it would favor the survival of the stronger, rather than the more intelligent, evolution might proceed in a downward direction.

Thus evolution gave rise to two contrasting world views — one optimistic, the other pessimistic. We will see both of these views reflected in the nineteenth century novel.

C) EVOLUTION AND THE NINETEENTH CENTURY NOVEL

1) NATURALISM — A PESSIMISTIC RESPONSE TO SCIENCE.

The pessimistic interpretation of Darwinian evolutionary theory resulted in the literary movement known as naturalism. Emile Zola is perhaps the best representative of this movement, for his Roman experimentale (1880) established the main principles of naturalistic fiction that other novelists of this school would follow.

Zola advocated an uncompromising realism for he felt that the novelist should depict human society and the lives of the men and women who compose it as objectively and as truthfully as the scientist presents his material. The novelist's function was not to interpret or embellish, but merely to observe and record events.

Zola identified literature with the new evolutionary science. He saw in Darwinian evolution a confirmation of the mechanistic theory suggested by Newton. In his novels, he tends to view man generically, that is, to see human beings merely as representatives of their species. And like Darwin, Zola emphasizes the role of heredity and environment, feeling that the interplay of these influences determines
the survival of both the individual and the species. As Sherman Eoff notes:

Zola sees human beings in synthesis with the species through three main avenues of observation: environment, heredity and sex. When viewed in close relation to his surroundings and especially to his living conditions, man is a heavy, earthbound quantity, acting more or less unconsciously in obedience to forces beyond his control.

The heavy shadow of material determinism lies over the characters of Zola's most famous novels; his characters are completely determined by their own heredity and the influence of their environment. Although they may struggle against these influences, they are trapped and ultimately destroyed by them. Man is therefore seen as a passive entity, subject to the external forces of the physical world over which he has little or no control. There is no free will; man merely acts out the role assigned to him by nature -- a role predetermined in every respect by physical influences.

In picturing man as trapped by his physical environment, Zola and his fellow naturalists usually deal with the more sordid aspects of life. Their characters are drawn from the lower levels of society and are driven by the most basic animal drives of hunger, sex, and survival. They are frequently alcoholic or sexually depraved and no detail of their sordid, unhappy lives is spared.

Naturalism, as Zola practiced it, was essentially a French movement and only "a comparatively minor outcropping of this kind of naturalism appears in Spain." Spanish naturalism can be seen principally in the novels of Vicente Blasco Ibáñez. In his works, the
environment is seen as a kind of mechanical force which pushes against man like a huge material object and ultimately crushes him. Thus in La Barraca Batiste and his family are victims of their environment; even their most valiant efforts to survive are useless in the face of the huerta -- "las tierras malditas llenas de desgracias" -- which destroys them.

Naturalism obviously embodied an extremely pessimistic philosophy. Man was one with the species and his character, indeed even his ultimate survival, was predetermined by the forces of heredity and environment. There was no room for individual freedom or for divine action. For this reason, most Spanish novelists were unable to accept the naturalistic style. Many Spaniards, like Pardo Bazán, praised naturalism for its literary qualities, especially its renewed emphasis on realism, but disagreed with the philosophical foundations of the movement. In La cuestión palpitante, Pardo Bazán disagrees with the naturalists' emphasis on the sordid aspects of life and points out the dangers of the materialistic determinism which destroys human will and denies the possibility of divine intervention. She notes: "acaso el mayor germén de caducidad del naturalismo fuese el haber hecho como si Cristo no hubiese venido al mundo." On the whole, then, Spanish writers rejected the pessimistic interpretation of evolution offered by the French naturalists and preferred instead the more optimistic interpretation of writers like Pérez Galdós. But naturalism marks the beginning of a current of pessimism -- pessimism occasioned by the results of the new sciences. It is this current of pessimism which will grow
stronger in the twentieth century.

2) PEREZ GALDOS -- AN OPTIMISTIC ADVOCATE OF SCIENCE

As we have observed, evolutionary theory was capable of generating optimism as well as pessimism and frequently gave rise to a belief in the inevitability of human progress. As Sherman Eoff puts it:

*It is simply a matter of shifting the emphasis from the past to the future to behold in evolution a plan that glorifies spiritual attainment, and suppose that the Supreme Mind is at work realizing itself in the natural process.*

The tendency toward this type of optimism was reinforced by a strong current of Hegelian thought that began to manifest itself in the latter half of the nineteenth century. Hegel was a brilliant spokesman for spiritual evolution -- the idea that the divine mind is at work in the evolutionary process. His philosophy was above all a philosophy of progress, and he advocated the idea that progress toward truth is a step in a transcendent movement achieved through the synthesis of opposites. Hegelian theory thus provided a view of evolution that focused attention on the later stages of man's history and shifted the emphasis from a deterministic past to an optimistic future. It is precisely this perspective that becomes evident in Galdós' novels.

Another factor contributing to the optimistic viewpoint championed by Galdós was the rise of social psychology in the 1880's. Psychology emphasized the relationship between the individual and
society, and stressed the fact that heredity as the natural agent and society as the environmental agent share responsibility in the creation of an individual. As Eoff points out:

A viewpoint that visualizes a continuously active combination of natural and environmental factors as an explanation of personality tends to de-emphasize the passive states of evolutionary development, in which man appears to be more or less at the mercy of a nature that looks only to the interests of the species. It allows, rather, for a process of give-and-take, in which the individual uses environment for his own good while being molded by it. A combination of the social and the psychical is thus made to provide a constructive basis for the human situation.14

Galdós combined Hegelian ideas with ideas from the new social psychology to form a novelistic outlook which Eoff refers to as "spiritual naturalism" -- an outlook "...which visualizes nature's organic constitution from a psychological or, more exactly, socio-psychological viewpoint, and which presents a picture of man achieving, singly and on his own responsibility but always in association with others, his oneness with the divine mind."15

Galdós' intellectual outlook embraces, then, the most positive and optimistic aspects of nineteenth-century thought: the concept of life as change and growth, the co-operative interplay of self and others, the belief that obstacles are but a challenge that leads to progress, and faith in the value of the individual. His is obviously an optimistic philosophy, and his optimism is closely related to his attitude towards science. As we have seen, a positive interpretation of the evolutionary theory is responsible for much of his optimism.
But even more importantly for our study, much of Galdós' optimism is based on the fact that he sees education -- especially education in the sciences -- as an instrument to aid the advancement of mankind. It is this vision that links him with Francis Bacon and with the eighteenth century reformers. Let us then examine Galdós' attitudes toward education and science as they are revealed in two of his works: the novel El caballero encantado and the play Amor y ciencia.

When we first look at the work of Pérez Galdós we are surprised by a striking resemblance to the writings of Cadalso and the other eighteenth-century reformers. Like Cadalso, Galdós criticizes the backward spiritual and intellectual climate of Spain, and like Cadalso, he is interested in education and science as the keys to progress. Casalduero offers an explanation for the continuing importance of these topics in the nineteenth century:

En la segunda mitad del siglo XVIII hubo en España un resurgimiento ideológico indudable, pero cuando debía dar sus frutos estalla la Revolución Francesa, luego las guerras napoleónicas, Fernando VII -- una de las peores calamidades que tuvo que padecer España -- y, por último, la primera guerra civil.\textsuperscript{16}

Casalduero explains that these historical upheavals interrupted the reform movements set in motion by the eighteenth-century reformers and prevented them from achieving most of the reforms they advocated. Their tasks remained unfinished; it was left for the men of the nineteenth century to again take up the work of reform. Among the unfinished tasks the men of the nineteenth century inherited was that of reforming the educational system. Indeed, seen in the light of
evolution and the newly established social sciences, education took on an even greater importance in the nineteenth century than it had enjoyed in the eighteenth:

...heredity and environment (race, milieu) had become important considerations. In an evolving world, man had to be examined with reference to the conditioning factors of his surroundings. All social institutions and activities were inherently educative. In addition, the concept of evolution implied a new meaning for education as a science. Since reform was possible, the methods for bringing about such improvement assumed greater importance. Education was at the heart of nineteenth-century problems. 17

We will remember that the centralized enlightened despotism had expelled the Jesuits in 1767 and placed all levels of instruction under state control. In the nineteenth century, however, public education reached an extreme low of decadence and abandonment. The Jesuits returned, and their colegios began to flourish again and to multiply throughout the peninsula. Neither the state nor the religious schools offered an atmosphere for the development of liberal ideas. Scientific studies in particular suffered, for the new sciences were often incompatible with the established order and with the ecclesiastical domination of the colegios. Governmental indifference to education was striking, especially during the first third of the nineteenth century. During the lifetime of Fernando VII, education rapidly declined. During this period:

Several universities were deprived of their entire property. The first report of the society for public instruction in Madrid, published in 1839, says: 'It is scarcely credible, but nevertheless true, that during the
reign of the Calomarde ministry in 1827, the sums intended for the salaries of professors of Hebrew and Arabic were appropriated by the government to pay for a school of bullfighting; matters became worse until Christine ascended the throne....

The relative liberalism of the reign of Isabel II resulted in some attempts at improvement. In 1845, a plan of studies established by Pedro José Pidal, the first Marquis de Pidal instituted a "complete secularization." Such projects, however, suffered greatly from the constant changes in government resulting from the pronunciamientos for which Isabel's reign was so notorious. In 1851, a concordant was signed in Rome, whose second article decreed that instruction in all schools had to be regulated according to the doctrines of the holy Catholic religion. The bishops and clerical superintendents of dioceses were therefore empowered to watch over the purity of morals and the education of the young in all schools, public and private.

In view of the importance of the educational question in the nineteenth century, it is not surprising that Galdós devoted a great deal of attention to this problem. Many critics have studied Galdós' attitude towards education as revealed in his social novels. Perhaps the most detailed of these studies is Charles William Steele's dissertation study entitled: The Literary Expression of Educational Attitudes and Ideas in the Novels of Pérez Galdós. Steele identifies five general phases in the evolution of the education theme in Galdós' novels:

(1) The initial identification of any of the aspects of education he chooses to mention under the general heading of clerical evils;
(2) a period of more objective, although still negative, interest in the various agencies of education -- society, family, teacher, school -- which, even though inevitably colored by clerical domination, are considered per se; (3) the most objective period of the realistic novelist, during which the persistent theme is contained in the broad topics of buena educación, experience as a teacher, and the uneducable índole for which existing educative influences are inadequate; (4) the 'spiritual' period during which the dominant note is the precedence of spiritual man over intellectual man, with an apparent rejection of scholarship and erudition; and (5) the later positive approach which asserts that the solution for Spain must be accomplished through a re-education of the national character.

It is the fifth and final phase which we see reflected in El caballero encantado (1909).

El caballero encantado is basically the story of the education of the central character, Tarsis, to be a better Spaniard. Since this educational process forms the entire plot, we should perhaps outline the basic action in order to provide a frame of reference for discussion.

Don Carlos de Tarsis y Suárez de Almóndar, Marqués de Mudarra, Conde de Zorita de los Canes, becomes an orphan at the age of twenty. Disregarding the advice of his clerical tutor and guardian, Tarsis begins to squander his fortune and lives extravagantly in Madrid, Paris and London. When his administrator reminds him of his impending bankruptcy, Tarsis' answer is an order to increase the taxation of his tenants.

On the verge of complete financial collapse, he visits his friend Becerro, a sort of scholar-magician who is fascinated with
genealogies. In Becerro's house, Tarsis talks into a mirror to Cintia, a girl with whom he has fallen in love in Paris. Tarsis then falls asleep and wakes to find Becerro has changed into a dog. The floor shakes, the house splits, and Tarsis finds himself on a grassy slope surrounded by a band of nymphs led by la Madre, who represents Spain or the soul of Spain. Henceforth, she will appear to him at intervals in various disguises.

The nymphs push Tarsis over a cliff and he awakens as Gil, a plowman and laborer on his own lands, but he does not remember who he is. Gradually he realizes that he is Tarsis, and that he has been enchanted in order to undergo a process of re-education. He next works as a shepherd and finally as a laborer in a quarry. Here he meets Pascuala, who is really Cintia undergoing a similar educative treatment. When she leaves to accept a position as a teacher in a neighboring community, Gil quits his job to follow her.

While following Cintia, Gil works as an excavator in the ruins of Numancia. Everything is gigantic in Numancia -- perhaps as a symbol of epic idealization. Tarsis next follows Cintia to Calatañazor, a small mountain community where she is teaching. When she tries to leave with him, a swarm of children hold her back and he has to leave without her.

While leaving Calatañazor, Tarsis meets Galo Zurdo, his competitor for Pascuala. Zurdo first appears as a giant pig and warns him to leave the region. Tarsis kills him and now must flee, because that part of Spain is controlled by the family and friends of his victim.
He is arrested by Regino, a member of the guardia civil whom he has met in Numancia. Regino says he will shelter Cintia in his home with his mother, but this prospect sends Tarsis into a furious jealous rage. He is thrown into jail. Later, while traveling on a road under guard, he escapes in a haze created by smoke from a burning inn. After his escape, he meets Alquiborontifosio, a teacher who had been introduced to him in Boñices, and the two become companions in misery.

Tarsis is arrested again, this time in the company of la Madre who has been accompanying him as a poor woman. They attempt to flee and are shot and killed. The guards leave them for dead, but they experience a resurrection. La Madre dives into the Tajo river and orders Tarsis to follow. As he is at the point of drowning, he is rescued by the inhabitants of a circular, fishbowl realm who wear red tunics and speak like fish with their eyes rather than their tongues. He learns that this is to be the last stage in his re-education, and that as soon as he completes this "cura de silencio," he may return to his former life. As he approaches the successful conclusion of his instruction, he again sees Cintia in a mirror. He finds that Regino has not been disloyal and she is safe.

At the conclusion, Cintia and Tarsis return to Madrid as if there had been no passage of time. She informs him that she has given birth to their son, whom she has named Hispero in memory of la Madre, and they plan optimistically for the future.

It must be said that El caballero encantado is not one of Galdós' better works. Indeed Sherman Eoff sees the novel as a loosely con-
structured work which, as he puts it, "shows definite marks of a decline in creative energy."^21 The work is fantastic and highly symbolic, but much of the symbolism is obscure and poorly developed. We can easily see, however, that its main theme is that of education. Tarsis undergoes a process of re-education under the guidance of La Madre, a symbolic character representing the spirit of Spain, both past and present. The curriculum through which La Madre leads Tarsis is divided into several broad areas of subject matter designed to strengthen both his body and will. First, Tarsis must learn the value of hard work in contact with nature. This lesson is learned while he works as a plowman, shepherd, and quarry laborer. At the same time, he undergoes a series of exercises in character improvement, culminating in the "cura de silencio," "...soberano remedio que atajaba el flujo de las palabras ociosas."^22 Cintia acts as the stimulus for these exercises in character improvement, for Tarsis is anxious to learn his lessons well in order to achieve their mutual disenchantment so that they may again be together. Concurrently with Tarsis' other disciplines, La Madre leads him in the study of Spain and the Spanish character. The two travel through Spain in both time and space, until Tarsis learns to value his Spanish heritage.

It is clear that the curriculum Tarsis and Cintia follow represents the new, reformed education Spain needs in order to progress. Once Tarsis and Cintia have undergone their respective re-educations under the guidance of La Madre, their goal will be primarily an educational one. They hope to reform Spanish education by re-educating their countrymen, teaching them the things they themselves have
learned as a result of their enchantment. They realize that:

La Madre impone su corrección a los hijos bien dotados de inteligencia, y que sufren de pereza mental o de relajación de la voluntad. En la naturaleza corregida de estos elementos útiles, espera cimentar la paz y el bienestar de sus reinos futuros (p. 346).

Their marriage may be seen as symbolic of the union of Spanish character with reason or education, and their son, the result of this union, will be "el maestro de maestros." This theme of education is emphasized in the closing lines of the novel as Cintia says:

Construiremos Veinte mil escuelas aquí y allí y en toda la redondez de los estados de la madre. Daremos a nuestro chiquitín una carrera; le educaremos para maestro de maestro (p. 374).

The work ends on a markedly optimistic note: using education as a tool, man can change; he can progress. To achieve this progress, Spain need only reform her educational practices so that she may use education to its fullest advantage in directing this progress. We might now ask, what role does science play in Galdós' concept of education? Does Galdós regard education in the sciences with the same optimism he shows towards education in general? In order to answer these questions we must turn to another of Galdós' works, the play Amor y ciencia (1905). It is here that we find perhaps his most explicit statements regarding science. Before discussing the work, perhaps a short plot summary is necessary.

As the play opens, Cristín, the young son of Paulina is critically ill and not responding to the treatment of the doctor Solís and Sor Elisea, Paulina's aunt. There are rumors that a famous doctor
"el más sabio, el más amañoado del mundo para robar enfermos a la muerte" has arrived in Madrid. Sor Elisea reacts to this news with some excitement. The falsely pious neighbors Natalia and Varona come to call and express their opinion that the boy is beyond the help of medical science and the only hope left is to commend him to God. We next learn that the famous doctor is none other than Guillermo Bruno, Paulina's husband. Paulina had had an affair with another man; Bruno had found out and thrown her out of his house. Her son Cristín is an illegitimate child, the fruit of her illicit love affair. Paulina has not seen her husband in seven years. Abandoned by her lover, she has been living with el Marques de Abdalá, a fatherly nobleman who has sheltered her and her son. Solís informs Abdalá that Guillermo Bruno's help represents the only hope of saving the boy and Abdalá attempts unsuccessfully to persuade Paulina to conquer her fear of Bruno, who has sworn to take revenge for her unfaithfulness, and allow him to treat her son.

As the second act opens, Abdalá has called Bruno and he comes to the house. While he is with Cristín, conversations between Natalia, Varona, and their son Adolfo serve to establish their characters. The shrewish Natalia reveals herself to be the epitome of false religion. She frequents the church, but lacks both true Christian faith and Christian morality. She is anxious that she and her family appear to be exemplar, but tolerates the infidelity of her husband as long as it is discreet, and condones her son's lax morals as long as he maintains the appearance of piety. She is utterly lacking in
true Christian compassion and unable to forgive; she actually hopes Cristfn will die to punish Paulina for what she considers to be her sins. Guillermo and Paulina talk while waiting for the medicines needed to treat the boy. Their discussion of their unsuccessful marriage shows that Paulina was immature, spoiled, and selfish. She regarded Guillermo's attempts to interest her in helping him in his scientific work as attempts to destroy her personality by remaking her in his image. Their conflicts made them hate one another. But Guillermo shows himself ready to forgive and promises to try to help, not harm, Cristfn. Paulina grants her reluctant permission, and vows before Elisea that if Guillermo cures her son, she will forgive him and seek a reconciliation.

In the third act, Cristfn's safe recovery is assured, thanks to Bruno's skill. Once the crisis has passed, Paulina returns to her frivolous and self-indulgent pursuits. Abdalá gently tells her that their union must end, for he wants to spend his old age with his daughter, who is returning to Spain. Elisea reminds Paulina of her promise to love Guillermo even if he does not love her, and with Abdalá gone, the way seems clear for their reunion. Paulina speaks with Bruno and expresses a desire to meet his "family" -- the women and children who have accompanied him. Guillermo says that he is leaving her in Elisea's care; when she has worked out her own salvation, he will return for her.

In the concluding act, Paulina goes to Bruno's residence and meets the women and children who surround him. They form an almost
utopian community living close to nature and practicing the ideals of hard work and Christian devotion. All have been helped by Guillermo -- the epileptics, the mentally disturbed and even the physically deformed like Guillermo's favorite child, el niño Dios. Paulina begs Bruno to allow her to remain with him and help him in his work. Guillermo gives his permission and the curtain falls on a scene of rejoicing at the return of the prodigal Paulina.

Throughout the work, Guillermo is seen as the personification of science. Natalia makes this identification early in the first act ("tu marido es la ciencia"). The plot is based on the conflict between the doctor, or science, and false religion and frivolity as symbolized by Natalia and Paulina. Natalia in her mistaken interpretation of religion believes that science is irrevocably opposed to religion. She sees in Christín's illness a struggle between the antagonistic forces of science and religion. She believes that God will condemn him because of Paulina's sin; all of Guillermo's science cannot save him. In this belief she, of course, underlines her own lack of understanding of true Christianity since she refuses to acknowledge the possibility of divine forgiveness. She also fails to see that God might act through the secular agency of science. She makes the comment that science could only be effective if it were practiced by priests, that is, if it were under ecclesiastical domination (p. 37). But Sor Elisea, who perhaps represents the spirit of true Christian faith, realizes that "la ciencia también es de Dios" (p. 26) and adds "Tengo en ella toda la fe que podemos poner en las cosas humanas."
Can Guillermo save Cristín and in so doing prove that science is not opposed to religion, but that indeed it may become a divine instrument? This question provides one source of suspense within the play.

The second conflict is generated between Paulina and Guillermo. Paulina could not endure marriage to the scientist because she felt science was destroying her spirit:

Querías que te copiara fórmulas antipáticas con terminachos científicos... que aborreciera los teatros y todas las artes que recrean el espíritu.... Tu afán era hacer de mí una sabia inaguantable (p. 41).

But her husband replies:

Yo no quería hacer de ti una sabia.... No pretendía que sacrificaras todo tu ser voluble, imaginativo, fantasioso, sino una parte de él. Quería yo que te asomaras contigo a la ciencia, no más que para tener yo el gusto de mostrarte sus maravillas más visibles, y para hacerte comprender que hay en el mundo algo más que modas, pasatiempos y frivolidades (pp. 41-42).

Guillermo obviously feels that Paulina is deriving spiritual satisfaction from trivial and frivolous activities, and that her very satisfaction with these meaningless activities signifies the shallowness of her spirit. He seeks to lead her to see a deeper meaning in life and advises her: "no alimentas tu espíritu con golosinas, sino con el manjar fuerte de la verdad, y aparta tus ojos de todo lo que no sea un ideal grande" (p. 73). Thus the conflict between Guillermo and Paulina provides another source of suspense: Can Guillermo make Paulina see the uselessness of her own existence and commit herself to a more meaningful way of life?
Guillermo is of course victorious in both these conflicts, and it is clear that Galdós means for us to identify Guillermo and science. What then are the characteristics of the science that Galdós chooses to portray as the hero of his drama? For Galdós, science would seem to be first of all a discipline that educates and perfects the spirit. Throughout the play Guillermo is shown to be a man with a full quota of human weaknesses -- he tends to be selfish, domineering and quick-tempered. We know that after he discovered Paulina's unfaithfulness, he flew into a rage and swore he would take revenge. Yet when he meets Paulina seven years later, he forgives her and cures her illegitimate son swearing, "...en mí no hay más ideal que el bien, ni otra pasión que la de la ciencia. La profesión que ejerzo me da grandes satisfacciones, y me impone deberes penosos que cumplo con firme voluntad" (p. 44). This statement and others like it seem to imply that Galdós attributes Guillermo's progressive ability to overcome his own weaknesses to the pursuit of his scientific studies, for these studies have given him a vision of the ideal and a commitment to serve this ideal. Paulina experiences a similar conversion once she understands the ideal nature of science.

Actually in Guillermo science is always seen in relation to ideal virtues. Science is first of all united with love. Referring to Guillermo's "family," Paulina asks: "¿Es esto la ciencia pura, o es una familia creada por el amor para el servicio de la ciencia?" Guillermo replies: "La ciencia crea; el amor embellece" (p. 89). The scientist serves mankind in the spirit of true Christian love.
Science is neither opposed to religion nor to the spirit, but rather provides an opportunity for true religious service and spiritual fulfillment. Practiced in the spirit of love, science can build the utopian society symbolized by the community Guillermo forms among his followers. *Amor y ciencia* can therefore be seen as a sort of celebration of the virtues of science.

To conclude, Galdós illustrates the optimism characteristic of much of the nineteenth century in his attitudes towards both education and science. These two disciplines are of course intrinsically related in the nineteenth century just as they were in the eighteenth. In order to progress in science, the old ecclesiastical educational system had first to be revised to accommodate this new secular study. Those who defended the new science were forced to crusade for educational reform as well.

We feel that Galdós, like Cadalso, advocates the study of science for its utility -- he sees science as a tool which Spain can use to progress. There is, however, a basic difference. Cadalso had been interested mainly in material progress which would improve Spain's economy and international prestige. Galdós seems equally interested in science as a tool for spiritual progress. He sees science as a discipline which can not only improve man's physical and material well being, but as a discipline which can ennoble and perfect his spirit. This emphasis on the spirit can perhaps be attributed to the strong Hegelian influence in the late nineteenth century. Galdós' optimism regarding science is characteristic of the nineteenth cen-
tury in general. As Hall notes:

Probably the public esteem for science was highest at the end of the nineteenth century, at a time when it promised peaceful communication between nations and the conquest of disease. It was a moment of self-improvement and idealism when...young men approached their careers in science with a sense of almost religious dedication.24

Much of this general optimism can be attributed to positive interpretations of the doctrine of evolution because such interpretations provided a scientific confirmation of the eighteenth-century dogma of progress. This dogma, together with the destruction of the theory of special creation, seemed to confirm the fact that man could change and perfect both his social institutions and his physical surroundings.

The interest in education, science, and national reform which we have seen in Galdós will continue in the twentieth century, especially with the so-called "generation of '98." But the writers of the twentieth century will not share the nineteenth century writer's optimism. Galdós' vision of a science which harmonizes with man's spiritual and religious needs becomes only a fading dream in the twentieth century, and the optimism accompanying his vision changes slowly into a bitter and apprehensive pessimism. Let us then turn to the twentieth century and attempt to document this change.


21 Sherman Eoff, *The Novels of Pérez Galdós*, p. 16.

22 Pérez Galdós, *El caballero encantado*, p. 332. All future page references are made to the edition cited in the bibliography.
23Pérez Galdós, Amor y ciencia, p. 14. All future page references are made to the edition cited in the bibliography.

24A. Rupert Hall, A Brief History of Science, p. 313.
It is clear that the twentieth century marks a point of demarcation in the cultural history of mankind. In his *Intellectual and Cultural History of the Western World*, Harry Elmer Barnes identifies four major world revolutions in the history of man: The first occurred between 1,000 and 2,500 B.C. and marked the emergence of the social order. The second was effected between 300 B.C. and 80 A.D. as ancient pagan imperial and metropolitan society fell apart and was replaced by the Christian Catholic feudal order. The third world revolution occurs in the time period embraced by our study -- 1500-1800 -- and is characterized by the change from Catholic agrarian feudalism to national states, international commercial relations, mechanical industry, capitalism, and the rise of the middle class. The scientific revolution whose origins we have traced in the sixteenth and seventeenth centuries was, of course, instrumental in bringing about these changes. The fourth great revolution is largely a product of the twentieth century and gives this century a markedly different character, separating it from the dominant ideological currents we have traced in the three preceding centuries. In this last great critical period the main social institutions that arose during the third world revolution are being subjected to the same strains.
stresses, and readjustments that befell earlier social orders. During the course of this latest revolution, we find a major turning point in both the discipline of science itself and in man's attitude towards science. In order to understand this change we must consider developments in both philosophy and science.

A) THE TWENTIETH-CENTURY REVOLUTION IN PHILOSOPHY AND PHYSICS

Even as science was constructing its model of the world machine run according to rational laws of cause and effect, philosophers began to rebel against this machine and the rational attitude that constructed it. In the midst of the "Age of Reason" Rousseau broadcast the seeds of a revolution against this enthronement of reason. To his romantic mind the domination of reason was intolerable. In his Confessions (1784) and major novels he emphasized the value of feelings as opposed to reason, of impulse and spontaneity as opposed to the more rational qualities of self discipline and restraint. Yet despite Rousseau's protests, the eighteenth century retained for the most part an unquestioning confidence in the power of science and logic to solve at last all problems.

The rebellion begun by Rousseau became stronger in the nineteenth century as serious thinkers began to examine the nature of the Reason which was destroying religion and locking mankind into the chain of universal mechanism. It was time for a critique of reason, and Immanuel Kant supplied it. In his epoch-making Critique
of Pure Reason (1781), Kant explored the possibilities and ultimately the limitations of reason. Kant establishes the basic principle that the mind and the objects it perceives are not separate entities. The mind is actively involved in what it experiences, for it organizes perceptions and experiences into definite patterns -- patterns which obey the laws of thought.

The world, then, has order, not of itself, but because the thought that knows the world is itself an ordering, the first stage in that classification of experience which at last is science and philosophy. The laws of thought are also the laws of things, for things are known to us only through this thought that must obey these laws, since it and they are one.

The principles on which science depends -- space and time, cause and effect, etc. -- are not things perceived, but modes of perception, ways of making sense out of the sensations that bombard us.

Since the concepts of cause and effect, etc. are concepts of mind, not innate laws of nature, we must accept the fact that science cannot be regarded as discovering the ultimate truth about the workings of the world. Science can only organize the world according to the laws of thought -- laws which may yield a faulty construction of the way in which the world really operates. This was a sobering consideration for the new sciences, confident as they were of unlocking the secrets of the universe and predicting events according to orderly relationships of cause and effect. What if the entire scientific construct was false? As Durant notes; The Critique of Pure Reason
...had destroyed the naive world of science, and limited it, if not in degree, certainly in scope, -- and to a world confessedly of mere surface and appearance, beyond which it could issue only in farcical 'antinomies'.

In short Kant denied the finality of intellect in the field of transcendental problems.

The philosophical assault against reason continued. Schopenhauer protested that reason was not the guiding force in human life. In the *World as Will and Idea* (1819, 1844), he insisted that blind will, the vital force uncontrolled by reason, is the ultimate reality. The world is will, and therefore strife, and therefore misery.

Nietzsche too emphasized the force of will. Writing under the influence of the evolutionary theory he felt that

...morality, as well as theology, must be reconstructed in terms of the evolution theory; and that the function of life is to being about 'not the betterment of the majority, who, taken as individuals, are the most worthless types,' but the 'creation of genius,' the development and elevation of superior personalities.

Nietzsche believed that all human behavior was motivated by the "will to power." This will to power was not to be understood merely in terms of achieving domination over one's fellows, but included man's achieving power and control of his own unruly passions. The ideal man was the Nietzschian "superman" -- the passionate man who learns to control his passions and use them in a creative manner. Nietzsche represented the culmination of the Romantic movement, the exaltation and the liberation of the Romantic will and the 'genius' of Schopenhauer from all social restraint. He was as Durant puts it "the last
great scion of the lineage of Rousseau."

Even after the Romantic movement had lost its force, philosophers continued to attack the domination of reason and the materialistic and mechanical systems reason had constructed. The mechanistic materialism which had given ground before Kant and Schopenhauer received new reinforcement from Darwin and Spencer and had regained most of its old power by the beginning of the present century. Bergson begins the attack anew. In *L'Evolution Creatrice* (1907), he revolts against the dominant materialism and attacks the mechanistic interpretations of evolution which see man as being completely determined by heredity and environment. Man is not a passively adaptive machine, Bergson argues, but a focus of redirected force, a center of creative evolution.

In short, beginning with Romantic thinkers like Rousseau, science and its methods were attacked by many critical thinkers. Men began to question the methods and the philosophical implications of the new science. This type of critical thinking becomes more frequent as we approach the twentieth century, and begins to dull some of the optimism which had accompanied the birth of the scientific method under Bacon. Some serious thinkers were beginning to lose faith in the power of science to unlock the secrets of nature and lead mankind along the road to progress. This loss of faith in science was paradoxically enough accelerated by developments in science itself, particularly by the twentieth-century revolution in physics.

By the nineteenth century, science had made great advances,
especially in physics and chemistry. The explanations of new discoveries all fitted together, giving confidence in the whole, and men came to believe that the major discoveries had all been made, and the main lines of scientific theory laid down once and for all. It seemed that further research would simply be a matter of refinement and consolidation — it only remained for the scientist to carry measurements to the higher degree of accuracy represented by another decimal place.

But within the first twenty years of this century, such complacency and security vanished. X-rays, electrons, quanta and relativity produced a complete revolution in physical science. The chemical atom, revealed by Dalton ninety years earlier, and accepted as the indivisible unit of matter, was shattered into fragments by J.J. Thomson and Rutherford. Then Planck was led to the theory that radiation was emitted in gushes or quanta, while Bohr and others imagined models of the atom in which Newtonian dynamics no longer held, and models discarded, explanations had finally to be left in the equations of a new science of wave-mechanics. Newton's ideas of absolute space and time and his scheme of gravitational forces, which had replaced Aristotle's teachings and ruled mechanics and astronomy for two centuries, were superseded by Einstein and the Theory of Relativity. Time and space became relative to the observer, and gravity a curvature in a space-time continuum. In short, the Newtonian universe blew up into the expanding universe of space-time. Matter and energy became equivalent; the uncertainty principle was enshrined. Science, which had seemingly been majestic, rational, and logical, in basically simple ways, became full of imprecisions and
paradoxes.

Most important of these discoveries for our study is Heisenberg's "Uncertainty Principle." In 1927 Heisenberg asserted the impossibility of determining which electron will next "jump" an orbit in an atom, thus radiating energy, or which atom of radium will next decay into an atom of radon. One could only predict the statistical probability of such occurrences. The implications of this discovery were staggering:

Paradoxically enough, it seems that, when we get down to those 'ultimates' involved in the realm of the atom, the only certainty in science today is the certainty of uncertainty. For all practical purposes, we may still follow most of the scientific laws and formulations worked out in the nineteenth century. Superficially and practically, they seem to describe the behavior of most physical phenomena as well as ever....But when we get down to fundamentals we have to take over a new set of concepts. As C.W. Gray puts it: 'Uncertainty reigns, and whether the universe is a world of fortuitous atoms or a world of freewill, it cannot be described in its fundamental physical aspects today as a world of causality.'

For a discipline that had developed for three centuries under the assumption of cause and effect relationships, Heisenberg's discovery was upsetting to say the least. However much nineteenth century science might have disturbed older notions, it was always able to fall back on one fundamental and reassuring concept -- that a definite cause-and-effect relationship existed in all the workings of physical nature. But as we have seen twentieth-century research in mathematical physics and electromechanics has undermined this concept.
As Barnes notes:

A generation ago, scientists believed that while the theologians and metaphysicians might be engaged in elaborate self-deception, the scientists were sure of their own ground. Today, the most candid scientists quite frankly confess that science cannot discover any ultimates, even in its own realm.\(^5\)

The developing science destroyed the sense of security men of previous centuries were able to derive from the old anthropomorphic and geocentric theology. Men began to place an almost religious faith in science, believing that science could discover the ultimate truth about the workings of the universe; the truth which theology no longer seemed capable of revealing. But after the new discoveries in physics it seemed that even science could not supply this certainty about ultimates. Indeed, it seemed that the very basis of science -- the concept of uniform, invariable and universal laws -- might have to be abandoned.

The principle of uncertainty says in effect: There is simply no sense in asserting what would happen if we knew the present completely. We do not, and plainly we never can. This is quite a different view of the world than that expounded by Laplace in 1820 in his *Theorie analytique des probabilities*:

An intelligence knowing all the forces acting in nature at a given instant, would be able to comprehend in one single formula the motions of the largest bodies as well as the lightest atoms in the world provided that its intellect were sufficiently powerful to subject all data to analysis; to it nothing would be uncertain; the future as well as the past would be present to its eyes. The perfection that the human mind has been able to give
to astronomy affords a feeble outline of such an intelligence. Discoveries in mechanics and geometry, coupled with those in universal gravitation, have brought the mind within reach of comprehending in the same comprehensive formula the past and future state of the system of the world.6

Nineteenth century thinkers like Laplace felt that science did not merely describe the world, it explained it. And by an explanation they meant a model which followed nature exactly, link by link, along a chain of causes and effects. This view can no longer be accepted.

Today scientists feel that:

The aim of science is to describe the world in orderly language, in such a way that we can if possible foresee the results of those alternative courses of action between which we are always choosing.7

The purpose of science is always to predict. The fundamental difference between nineteenth and twentieth-century science is that the nineteenth century felt that causal laws could be established which would predict with certainty the various phenomena of the natural world. Twentieth-century science has abandoned any such claim to certainty and is replacing causal laws with statistical laws. As Bronowski explains, twentieth-century science

...uses no principle but that of forecasting with as much assurance as possible, but with no more than is possible. That is it idealizes the future from the onset, not as merely determined, but as determined within a defined area of uncertainty.8

Thus contemporary science has replaced the concept of inevitable effect with the statistical concept of probable trend. This new scientific orientation makes it clear that problems like Free Will or
Determinism are simply misunderstandings of history. History is neither determined nor random. At any moment, it moves forward into an area whose general shape is known but whose boundaries are uncertain in a statistically calculable way.

In conclusion, even before the twentieth century, a revolt against the domination of scientific habits of thought and science in general was begun by the thinkers of the Romantic period. Although all of these thinkers attacked science in their own individual ways, their protests were all essentially based on spiritual grounds. They protested the fact that the scientific reliance on reason did not give sufficient consideration to the vital forces -- emotion, intuition, will. These thinkers particularly objected to the mechanistic interpretations of the universe science was proposing, for they believed mechanism underestimated the importance of the individual human will. At the same time other thinkers like Kant attacked science from another, more philosophical vantage point as they questioned the limits of human knowledge and science's final authority in the field of transcendental problems. What all of these thinkers were saying in their various ways was this: science is not all inclusive or all important; science has its limitations; life is more than science can understand or predict. Surprisingly enough, discoveries in twentieth century science itself supported this conclusion. Science was forced to recognize its limitations, forced to realize that many of its treasured doctrines like the law of cause and effect might indeed be, as Kant had seemed to suggest, mere
habits of thought which had little correspondence to the way in which the universe actually worked. Scientists themselves were forced to admit that they were incapable of discovering ultimate truth. Science thus reinforced the suspicions of many critical thinkers. The destruction of the concept of science's infallibility lead to a certain pessimism, for now men were left with no certainty, no channel through which they could discover the answers to ultimate questions. Science had largely destroyed the faith of many in the ability of theology and religious institutions to supply these answers. Men had turned to science in search of truth, and now science proved itself incapable of supplying it. The consequent loss of faith in science began to destroy the optimism which had formerly surrounded science. Men soon began to adapt a quite pessimistic attitude towards science. Let us explore this change in attitude as it is revealed in the twentieth century novel.

B) THE TWENTIETH CENTURY NOVEL

1) THE GENERATION OF '98 -- AMOR Y PEDAGOGIA

The first Spanish literary movement of importance in the twentieth century is that represented by the "Generation of '98." This generation of authors marked a turning point in the history of Spanish literature for various reasons. Motivated by Spain's disastrous defeat in the Spanish American war, authors looked once more at the national character and attempted to define and solve the problem of
Spain. Eighteenth century authors had also been concerned with this problem; with what they felt to be the backwardness and inadequateness of Spanish life. But the eighteenth century studied Spanish society critically and objectively and attempted to solve Spain's ills through specific social reforms. The authors of the generation of '98 are much more subjective in their approach. They in effect seek to interpret the reality of Spain through the medium of their own spirits. They see the agony or angustia of Spain mirrored within their own spirits. Faced with the problem of Spain, compounded by the recent disaster, there are two courses of action open to the authors of this generation: they can act to reform Spain or they can attempt to escape the problem, using literature as their vehicle. Most chose the second alternative. Since the failure of the eighteenth century reforms, Spain had become progressively less able to accommodate herself to the technological society and to the new philosophy emerging throughout the rest of Europe as a result of the Scientific Revolution. Her inadequacy became so marked that the authors of the generation of '98 felt powerless to reform their country -- they could only retreat into themselves, and dream, and wait. Frustrated reforms were coverted into dreams. The literature created by this new generation was markedly different from that which had preceeded. On the whole, these writers avoided the rhetorical and relied on the evocative power of simple description. They attempted to create a natural language, a language tied to the reality of the things it evoked. Many authors were drawn to the Castillian countryside and delighted in painting
Castilla and her cities as they sought the reality of Spain. Many also turned to the simple everyday occurrences of life, to the intra-historia and saw the reality of Spain in these changeless patterns.

For our purposes, however, we will be more interested in the ideology of this generation than in its particular literary style. We find that this generation marks the beginning of the loss of faith in human progress, and the loss of faith in reason as the means of obtaining this progress. Under the influence of Nietzsche, writers began to assert the superiority of vitality, of life to reason. Lafn Entralgo writes:

...el optimismo progresista, tan incuestionable en los años que preceden al vivir de los hombres venteadores y agoreros de la crisis (Nietzsche, Dilthey, Ibsen, el propio Bergson), será pronto signo de filisteísmo, como desde Nietzsche es moda decir. Irracionalismo, sed de nueva vida espiritual, sentimiento de amenaza y, a veces, pesimismo manifiesto --más o menos cubiertos por los velos de la estética y del hedonismo-- van siempre hacia 1890 las nubes de hogano. La generación que recibió sus primeras impresiones científicas hacia los años sesenta y setenta del siglo pasado --ha escrito Spranger--, estaba completamente inmersa en las categorías biológicas y dominada por el esquema básico de la teoría de la evolución, hasta el punto de que, como se sabe, muy notables cultivadores de las ciencias del espíritu...esperaban que la salvación científica vendría a extender estos conceptos fundamentales a sus propios problemas. Hacia 1890 comenzó un giro decisivo en la vida entera del espíritu. Desde entonces está lleno el aire de intuiciones fundamentales pertenecientes a las ciencias del espíritu, y su repercusión sobre las ciencias naturales (por ejemplo, en el modo de entender el concepto de forma y el de organismo) es de todo punto evidente.
Esa es la situación histórica del espíritu europeo que confusamente perciben, cada uno a su modo, los hombres de nuestra generación de '98. Para todos ellos, la vida es superior y irreductible a la razón, el sentimiento superior a la lógica, la sinceridad más valiosa que la consecuencia. Cuantas palabras expresan la actividad no racional de la vida humana -- pasión, voluntad, sentimiento, sensibilidad inefable, emoción -- se hallan estampadas con rara frecuencia en las páginas de todos los autores del grupo.9

We can see this new viewpoint reflected in the work of one of the most widely read authors of the generation of '98, Miguel de Unamuno. His short novel Amor y pedagogía (1902) perhaps reflects his generation's changing attitude towards science better than any other single work. While admitting in his prologue that many readers have been unable to understand his purpose or the theme of his novel, Unamuno notes:

A muchos parecerá esta novela un ataque, no a las ridiculeces a que lleva la ciencia mal entendida y la manía pedagógica sacada de su justo junto, sino un ataque a la ciencia y a la pedagogía mismas, y preciso es confesar que si no ha sido tal la intención del autor -- pues no resistimos a creerlo en un hombre de ciencia y pedagogo -- nada ha hecho por lo menos para mostrarnoslo.10

Amor y pedagogía is basically the story of Avito Carrascal -- "Hombre del porvenir....joven entusiasta de todo progreso y enamorado de la sociología" -- and his attempt to create a genius through the application of sociological pedagogy. Avito, Unamuno notes, has already carried out the Herculean task "de enderezar con la reflexión todo instinto y hacer que sea en él todo científico. Anda por
mechanica, digiere por quimica y se hace cortar el traje por geometria proyectiva." In the light of his personal success in dominating his instincts and passions and living totally according to rational principles, Avito has every reason to believe that he will be successful in creating a genius. His premise is simple:

Tómese un niño cualquiera, digo, tómesele desde su estado embrionario, aplíquesele la pedagogía sociológica, y saldrá un genio (p. 24).

In order to prove this premise, Avito decides to marry and use the son resulting from this union as the subject of his experiment. He considers all of the genetic qualities that the mother of his future genius should possess — "Por amor a la pedagogía va a casarse deductivamente." He chooses Leoncia Carbajosa as his ideal mate, but when he goes to her house to propose marriage, he meets Marina, and entranced by her physical attractiveness marries her instead. Unamuno notes simply "Desde las excelsas cimas de la deducción se ha despeñado a los profundos abismos inductivos." Avito relationalizes his fall by saying to himself that Marina will provide the material for the future genius while he will supply the form.

Marina becomes pregnant and Avito carefully supervises her activities to obtain the optimum prenatal environment. Immediately after the birth of his son, Apolodoro, Avito begins to apply his pedagogical principles. He surrounds his infant son with all sorts of scientific paraphernalia so that wherever the boy looks he will be stimulated by science. Indeed, the house is a sort of "microcosmo racional" complete with its altar to science "un ladrillo en que está
grabada la palabra Ciencia, y sobre él una ruedecita montada sobre su eje." (p. 41).

While inundating the boy with everything representing rational science, Avito is careful to shield him from the irrational influences of love, religion, and superstition. These elements of life are personified in Marina who retreats into a dream-like state of irrationality, emerging only periodically to smother Apolodoro with love, teach him snatches of superstitious verse, or passages from the Lord's prayer.

Avito entrusts Apolodoro's education to "el insondenable filósofo Don Fulgencio Entrambosmares." Don Fulgencio's speciality is the aphorism and he is writing a work entitled Libro de los aforismos o pfldoras de sabiduría. But his masterwork is to be his profound Ars magna combinatoria. Philosophy, according to don Fulgencio, is nothing more than a system of combinations carried to its ultimate terms. Accordingly, he has chosen four seminal ideas: from the ideal order the ideas of life and death, and from the real order the ideas of right and duty. Starting with these four key ideas, and co-ordinating them in every possible scheme, Don Fulgencio expects to decipher the mystery of the universe. For him the end of science is to catalogue the universe "Para devolvérselo a Dios en orden, con un inventario razonado de lo existente" (p. 52).

Apolodoro's education, however, soon suffers two major setbacks. He becomes attracted to sentimental literature, and he falls in love with Clarita, the daughter of his drawing instructor. He attempts
to write a great sentimental novel based on his love for her, but the novel turns out to be incredibly bad and its publication brings disgrace to its young author. Worse still, Apolodoro loses Clarita to his rival Federico.

Depressed and haunted by visions of suicide, Apolodoro turns to don Fulgencio for help. But to his dismay don Fulgencio offers no consolation. Instead, the old man breaks down and confides to Apolodoro that all his eccentric philosophic pursuits are motivated by "Erostratismo." He explains that men can no longer believe in the immorality of the soul, and death thus terrifies them. Don Fulgencio is afraid of dying; he wants to live forever as a man of flesh and blood, yet he is tormented by the fact that reason tells him this is impossible. His only hope for a type of immortality is to leave a son or to obtain fame through his work. This is why he directs all his energies toward writing the great book that will immortalize him. Yet he confesses his despair over being childless and leaves Apolodoro with this advice "lo mejor es hacer hijos."

With nowhere left to turn, Apolodoro commits suicide, but not before following Don Fulgencio's advice and leaving the family maid, Petra, pregnant with his son. As Avito and Marina discover his body, Avito murmurs in his wife's arms "el amor habfa vencido." He soon recovers his faith in the power of sociological pedagogy, however, and plans to renew the experiment with Petra's child, confident that he can keep the boy isolated from the destructive influence of love that Apolodoro succumbed to and at last create his genius.
In studying *Amor y pedagogía* we immediately note its contrast to *Amor y ciencia*. In Galdós' work love and science were seen to be in harmony. Paulina was led to love through the agency of science, and both love and science were united in the figure of Guillermo. Unamuno, on the other hand, sees love and all the vital forces of life in contrast and in conflict with science and its allied rational discipline of pedagogy. Science or reason attempts to dominate life, but is never successful. This idea is emphasized by the fact that all of the male characters fall victim to the irrational vital force of love. Avito thinks he has rationally dominated his instinctive, vital nature, but he is obviously proven wrong when he falls in love with Marina and marries, not under the guidance of rational selection, but rather of sexual attraction. The same thing happens to Apolodoro. Rationally he knows Clarita is homely, boring, and actually not too bright, yet he cannot help loving her. Even the great philosopher don Fulgencio falls before the sensual attractions of his wife. All of the women represent life's vital, irrational forces -- the forces that seek satisfaction in love, and, in the case of Marina, in religious beliefs, superstition, and dreams. This contrast between the male and female characters, each representative of opposing forces, emphasizes the idea of the conflict between science or reason and life.

Why are these forces in conflict? Don Fulgencio gives Unamuno's answer. Reason and science destroy man's religious faith and his belief in immortality. Like don Fulgencio, man is left in a state of agony as he tries to attain immortality by making his name imperish-
able, realizing all the while that the attempt is futile. Reliance on science simply cannot fill the void left by the religious faith it destroys.

Science is inadequate for other reasons. Pure science is often meaningless. This lack of meaning is obvious in don Fulgencio's "scientific" work. Even if he succeeds in "cataloguing" the universe and placing it in order, he will still not understand its meaning. Don Fulgencio is fascinated by the science of "cocotología" or "la ciencia que trata de pajaritas de papel" (p. 151). He is entranced by cocotología because, as he says, "puede llegar a ser ciencia perfecta." But the point is, of course, so what? Even if one can reduce making paper birds to a pure science, what is accomplished? It is absolutely irrelevant and meaningless with regard to the conduct of our daily lives and answers none of the vital questions that plague us. The same thing is true of actual discoveries in science. The discovery of the origin of the universe or of the ultimate particle are really meaningless to us. They answer none of our vital needs. As Apolodoro asks: "¿...para qué quiero la ciencia si no me hace feliz?" (p. 116). And again: "¿...la ciencia me enseña a ser querido?" (p. 119).

Unamuno uses the entire plot of his work to illustrate the insufficiency of Avito's naive optimism about the effectiveness with which man, acquainted with a smattering of scientific or pseudo scientific information, can control nature and, specifically, shape human nature. As one critic summarizes:
If one is to attempt to say what the 'pedagogy' of the novel consists of, one might do best to quote Avito Carrascal himself, as he reappears twelve years later, in Niebla: "Ensena mucho la vida, y mas la muerte; enseñan más, mucho más que la ciencia."11

Amor y pedagogía is concerned with an affirmation of life. Unamuno's central thesis seems to be that life, the vital force, is stronger than the rational. Ironically Avito, who sees himself as a thoroughly rational man, is really acting under the influence of a vital need -- the need to secure his own immortality. As Donald Fabián notes:

D. Fulgencio de Entrambosmares, Avito Carrascal's mentor, gives the clearest indication of why Avito wanted to create a genius when he tells Apolodoro that 'el erostratismo es la enfermedad del siglo...la que te hemos querido contagiar.' The essence of 'erostratismo' is an effort to secure immortality in an age of disbelief in religion by making one's name 'imperishable'; 'lo más seguro es tener hijos.'12

Even Apolodoro's suicide may, paradoxically enough, be seen as a part of this affirmation. Shortly before he hangs himself Apolodoro sees a corpse floating down the river and discusses suicide with his rival Federico. Federico believes: "Sólo se suicida el que odia a la muerte; los melancólicos enamorados de ella viven para gozar en esperarla, y así, cuanto más tiempo la esperan, más tiempo gozan...." This idea, together with Apolodoro's determination to father a child before he dies, seems to indicate that even his suicide was in reality a triumph and an affirmation rather than a negation of life.

The final irony of the novel is the fact that despite the repeated demonstrations of the impossibility of dominating vital forces
with reason, Avito never realizes his mistake. He goes on, attempting to irradiate life by bringing it under the domination of reason. He plans to repeat his attempts to create a genius, this time using Apolodoro's son. Referring to Apolodoro, Avito says simply:

Para algo me has servido, para algo servirás a la humanidad, porque ahora se pone en claro que no haremos con la pedagogía genios mientras no se elimine el amor (p. 120).

He is convinced his experiment failed because the controls were not strict enough; the boy was allowed to fall in love and this was his downfall. He never realizes the manifest impossibility of bringing life completely under rational control, and he never realizes that love and pedagogy, the vital and the rational, should not be separated. Both must be given their proper place. Apolodoro realizes this and asks his father: "¿y por qué no hacer del amor mismo pedagogía, padre?" (p. 120). This would seem to be Unamuno's question. In an age of increasing emphasis on science, Unamuno sees the possibility that this emphasis on the rational may destroy the vital. He warns against the over-emphasis of science. Neither the rational nor the vital alone is sufficient. We must allow both their proper place. Neither Mariana, who is completely irrational, nor Avito, who is striving to be completely rational, can function successfully as individuals. A synthesis of the two is needed.

The important point we need to emphasize here is that Unamuno, unlike Galdós, does not see love and science as being in harmony. In Amor y pedagogía we see for the first time the idea that education
and science will not inevitably lead to progress. The overemphasis of science is in conflict with love and all of life's vital components. Indeed science may even destroy life rather than bettering it. This growing fear of science is symptomatic of the change of attitude toward science that begins in the early twentieth century. But in Unamuno and in most of the other members of his generation, the pessimistic view of science is softened by irony and humor. As Glicksberg notes:

The spirit of irony is today woven into the fabric of the tragic vision. Refusing to be deluded by Romantic utopianism, the cult of progress, the dream of human perfectibility, the tragic vision responded to Nietzsche's call for laughter. It sought to arrive at its own understanding of the unavoidable frustrations and limitations of life: what is possible and what is forever impossible. Such insights intensified the value of laughter. The tragic vision of life was now incorporated with the comic vein, the sense of the absurd.13

As the twentieth century progresses, pessimism deepens and the tone of much literature becomes more bitter. The irony often remains, but it frequently becomes more biting satire and is usually not softened by the humor we see in Unamuno. The tragedy becomes too great for humor.

2) THE CONTEMPORARY NOVEL - TIEMPO DE SILENCIO, CORTE DE CORTEZA

The deepening pessimism of mid twentieth century can be attributed mainly to the effects of two world wars, and in Spain, to the effect of the Spanish Civil War as well. The wars dramatically demonstrated
that the eighteenth and nineteenth century dogma of inevitable progress was untenable:

In the nineteenth century material progress and advancing science seemed to assure man that the future would be bright -- knowledge and technique would erase the dark areas of mystery which had been the field for religious life. But in the twentieth century science and technology inadvertently conspired to reveal in the World Wars depths of human existence that appeared incommensurate with rational comprehension and control. The nineteenth century gospel of progress, victory over the multiple of evils of the world by rational means, seemed incapable of standing up to the demonic evil of the concentration camp or obliteration bombing.14

The wars destroyed belief in progress and weakened man's faith in science as the agent which would secure this progress. As we would suspect, the wars have been particularly damaging to Spain's confidence in science, for as we have seen, beginning in the eighteenth century Spain accepted the new sciences only with grave reservations. Spain has always tended to fear that science would destroy her traditions, particularly her religious traditions. She accepted science only for its utility, for the material benefits it could bring. But the world wars showed that science could not only create; it could destroy. Science was not inevitably useful in constructive ways.

The world wars also contributed to twentieth-century pessimism as a result of the advances in technology they stimulated:

In modern times, advances in technology have been held to provide the most certain basis for the improvement of the human condition and to contribute the most solid substrate of progress.
But, as technology came to affect more of human existence, it became apparent that technology would in turn pose new and serious problems for man. In numerous situations the combination of technological developments and considerations of economics or natural defense seemed to conflict with the welfare of individuals or even of mankind as a whole.15

Rapid advance in technology always upsets the existing order because it creates what is known as cultural lag. This means simply that changes in technology take place more rapidly than our institutions, mental attitudes and social thinking can change and adapt themselves. As Barnes notes:

In all of the great world revolutions since primitive times cultural lag has been the factor which upset the existing pattern of life. And never before has there been such a gulf between technology and social institutions as exists today.16

Today we have an impressive and up-to-date equipment of science and material culture, but our institutions and social thinking through which we seek to control and exploit this novel and complex material culture are an antiquated mosaic, compounded mainly as Barnes puts "of accretions from the Stone Age to the close of the eighteenth century."17 This twentieth century gulf between material culture and social institutions is formidable in the most progressive countries, but in more conservative countries like Spain it becomes truly staggering. We have seen that many of Spain's attempts to reform her social and educational institutions in the eighteenth century were frustrated by the conservative reaction at the end of the century. Attempts at reform were continued throughout the nineteenth century,
but continually met with conservative opposition. Ecclesiastical domination of the educational system prevented the entrance of new ideas, and Spanish institutions were therefore less progressive than many of their European counterparts. Thus when faced with the technological advances of the twentieth century, Spain was even less able to cope with this new culture than were many other nations, and suffered from an even greater degree of cultural lag.

Perhaps the most damaging aspect of cultural lag is that it leaves the individual to face the stresses created by the rapidly changing culture on his own resources. He can no longer turn to the old social institutions like the church which once provided him with comfort and security. Science has destroyed a great deal of religious faith and even the remaining faithful find it hard to derive help for their contemporary problems from an institution which has changed little since the middle ages. The social sciences which might offer some guidance have not developed to keep pace with technology and are often unable to offer any useful solutions to today's social problems. This underdevelopment of the social sciences is, ironically enough, frequently due to our tendency to place too much confidence in technology itself. We tend to assert that the way to solve the problems of a society which is already in trouble because science and technology are way ahead of institutions, is to increase the emphasis on natural science and engineering in our curriculum in the hope that science will solve our problems, and to reduce the attention given to the social sciences. The old confidence in science dies hard.
Actually, as J.C. Garrett notes, even at the beginning of our century "The doctrine of perfectibility enunciated in the Romantic period, and later strengthened by Victorian interpretations of evolution, still had considerable currency." H.G. Wells' immensely popular novels: *A Modern Utopia* (1905), *Men Like Gods* (1923), *The Shape of Things to Come* (1933) continued to express man's faith in the desirability and attainability of a utopia directed by scientists.

But the impact of the first world war and its consequent technological advances soon began to have its effect, and confidence in science began to fade. Aldous Huxley's *Brave New World* (1932) marks the beginning of this change. Huxley and other writers began to rebel against the degradation of man by utopia. They began to see that technology might well come to rule man and be used to mold the citizens of scientific utopias. Anti-utopias began to appear. In 1947 George Orwell wrote *1984* and as Garrett puts it:

...a dinginess has fallen over the bright shiny surface of Utopia. Orwell is not willing to concede that in outward appearance, or even in material comfort, Utopia will have anything to commend it.19

1984 marked the development of a world wide shift in attitude toward science, a shift toward what many authors have come to call the "Orwellian outlook." In contrast to Bacon's concept of the ideal utopia, directed by scientists for the good of all humanity -- the ideal we have seen reflected in the eighteenth and nineteenth centuries -- authors began to write anti-utopian novels which pictured the scientist as a type of Frankenstein presiding over a technological hell
which destroys the individual. We can begin to see this Orwellian outlook reflected in the contemporary Spanish novel of the 60's, particularly in Tiempo de silencio (1962) and Corte de corteza (1969).

Tiempo de silencio, written by Luis Martín-Santos, is the story of a young cancer researcher whom we know only as Pedro. Pedro and his assistant, Amador, are experimenting using a special strain of rats imported from U.S. laboratories. This particular strain of rats develops a form of hereditary cancer, and dies soon after reaching maturity. Under laboratory conditions, their death rate exceeds their birth rate and the last of the strain dies. But the Wily Amador has taken a pair of rats from the lab and given them to Muecas, a slum shanty town dweller who steals cats and dogs and through Amador sells them to the lab. Muecas has been able to successfully breed the rats in his shack and now will sell them back to Pedro. Pedro decides to go to Muecas' shanty to see the rats and ascertain whether or not they are the legitimate descendents of the cancerous strain.

Martín-Santos now leaves the previous narration and begins the narration of the landlady who runs Pedro's boarding house. This history recounts her struggle during the years after her husband was killed, and her daughter's love affair which resulted in the birth of Dorita, the illegitimate granddaughter. Dorita is the old woman's pride and joy and she constantly schemes to arrange a good marriage for the girl.

Pedro and Amador arrive at the shack where Muecas, his wife and two daughters share a filthy matress under the hanging rat cages.
Muecas has devised a method to encourage the rats to reproduce. He has his daughters hang them in plastic bags between their breasts so that the girls' body heat will bring the creatures into heat.

The narrative goes back to the boarding house to show it this time from Pedro's point of view. Cartucho, the boy friend of Florita, Muecas' eldest daughter, is the subject of the next narrative. He has killed one of his former girl friend's lovers and is now jealously anxious to assure Florita's fidelity to him. Pedro leaves the boarding house and goes to a cafe where he meets a wealthy friend, Matfas. The two get drunk and go to a whorehouse. Upon his return home, Pedro goes into Dorita's room (placed conveniently close to his own by the conniving grandmother) and makes love to her.

Muecas comes to Pedro's room and wakes him, urging him to come to his shack to treat his hemorrhaging daughter. When Pedro arrives, he finds Florita dying from a botched abortion. His attempts to save her are futile and she dies. Cartucho believes that Pedro was the father of the child and therefore attempted to abort Florita.

The narration now switches to Matfas' house where Pedro attends a lecture given before a gathering of intellectuals. It is here that he receives word the police are looking for him as a suspect in Florita's death, for an autopsy has revealed she died as a result of an abortion attempt and he was seen leaving the shack. Pedro and Matfas flee and Matfas tries to hide the fugitive in the whorehouse they had previously visited. The police discover him there and arrest him. Everything he says in his defense only serves to further incriminate him and in
the end he is freed only because Muecas' wife insists he did not perform the abortion, and only attempted to save the dying girl. Pedro's immense relief on being released soon turns to despair as the director of the research institute tells him his grant is being revoked for the suspicion of guilt he has incurred through his involvement in Florita's death.

Pedro leaves the director's office and returns to the boarding house where a party is being given to celebrate his engagement to Dorita. After the party he takes Dorita and her mother to a play and festival. While he is buying refreshments at the festival, Cartucho stabs and kills Dorita.

The novel ends with Pedro's thoughts being given in a stream of consciousness technique as he boards a train taking him away from the city and the research work he loves to an obscure medical practice in the provinces.

A plot summary is always inadequate for the comprehension of a work of art, but is particularly inadequate in the case of Tiempo de silencio. Martín-Santos' work represents a virtual stylistic renovation of the modern Spanish novel, and none of his complex stylistic innovations can be conveyed in a plot summary. As Janet W. Diaz notes: "The plot is of less importance than style, characterization and ironic commentary on various aspects of Spanish life." A plot summary will, however, give us a point of reference for the discussion of our theme -- the view of science the novel projects. Science is certainly not the principal theme of Tiempo de silencio; the novel is more concerned with "el deseo del novelista en aprehender con sus
The novel does however convey a certain implicit view of science.

In one of its many aspects, Martín-Santos' novel represents the de-mythification of science and the scientist. The author destroys the concept of the omnipotence both of science as a discipline and of the scientists who devote themselves to this discipline. Martín-Santos accomplishes this de-mythification through both the literary use of irony and the use of more subtle stylistic techniques based on his manipulation of language.

Science is made to appear ridiculous firstly by the obvious irony that not only is science incapable of solving the mystery of life and death (symbolized by cancer), science cannot even succeed in breeding the rats it needs for its experiments. Muecas, however, without the vaguest notion of scientific procedure, succeeds where science had failed and breeds the rats quite easily. Science is thus made to appear completely useless.

But Martín-Santos goes even further. Not only is science made to appear useless, it is shown to be a hindrance to reaching truth. Pedro's scientific outlook leads him to faulty judgements and absurd conclusions when applied to non-scientific problems. This is evident in his first impression of the chabolas:

...un grupo achabolado como aquél no deja de ser al mismo tiempo recreo para el artista y campo de estudio para el sociólogo. ¿Por qué ir a estudiar las costumbres humanas hasta la antipódica isla de Tasmania? Como si aquí no vieramos con mayor originalidad resolver los eternos problemas a hombres de nuestra misma habla. Como si no fuera el tabú del
incesto tan audazmente violado en estos primitivos tálamos como en los montones de yerba de cualquier isla paradísica. Como si las instituciones primarias de estas agrupaciones no fueran tan notables y mucho más complejas que las de los pueblos que aún no han sido capaces de sobrepasar el estado tribal. Como si el invento del bumerang no estuviera tan rotundamente superado y hasta puesto en ridículo por multiples ingeniosidades -- que no podemos detenernos a describir -- gracias a las cuales estas gentes sobreviven y críen. Como si no se hubiera demostrado que en el interior del iglú esquimal la temperatura en enero es varios grados Fahrenheit más alta que en la chabola de suburbio madrileño. Como si no se supiera que la edad media de pérdida de la virginidad es más baja en estas lonjas que en las tribus del África central dotadas de tan complicados y grotescos ritos de iniciación. Como si la grasa esteatopigia de las hotentotes no estuviera perfectamente contrabalanceada por la lipodistrofia progresiva de nuestras hembras mediterráneas. Como si la creencia en un ser supremo no se correspondiera aquí con un temor reverencial más positivo ante las fuerzas del orden público igualmente omnipotentes. Como si el hombre no fuera el mismo, señor, el mismo en todas partes: siempre tan inferior en la precisión de sus instintos a los más brutos animales y tan superior continuamente a la idea que de él logran hacerse los filósofos que comprenden las civilizaciones.  

Pedro knows nothing of the chabolas. When he sees them, he examines them in the light of his scientific reason, comparing them with the constructions of other primitive peoples. He looks at the chabolas and their inhabitants with the objective eye of the cultural anthropologist. Viewed in this way the chabolas are remarkable, even poetic examples of man's ability to cope with his environment. His objective, scientific viewpoint prohibits Pedro from seeing the chabolas for
what they really are -- squalid, degrading abodes of human suffering -- a form of social cancer.

The implication seems clear; when science is applied to non-intellectual problems it produces fallacious results. The same is true of technology; when misapplied it becomes ludicrous and absurd. Martín-Santos emphasizes this point in his description of "los enterramientos verticales" (pp. 142-147). The narration begins with a discussion of the differences between mass production and the production of only limited quantities of manufactured goods, and the Taylor-Bedaux system. This discussion serves to set the proper scientific tone which will be maintained throughout the narrative. The efficient burial technique is then described, continually emphasizing the inherent rationality of the mass production technique. Martín-Santos underscores this rationality by the repeated use of the word "racional" and its derivatives throughout the passage. But the point is, of course, that when the rational technique of mass production is applied to the non-rational realm of death and the attendant human emotions the result is patently absurd:

Puesto que el tiempo invertido en cada pieza oblonga está bien determinado, viene a constituir el orden de periodicidad básico al que se añade un coeficiente corrector basado en el respeto al dolor humano de los deudos (p. 144).

As if the human suffering of the bereaved could or should be reduced to a mathematical formula! Here again science ends in the absurd when applied to non-scientific, non-intellectual problems.

Throughout the novel science, reason and technology are progres-
sively stripped of the idealistic halo they had acquired in the hands of optimistic nineteenth-century authors like Galdós. The scientist himself suffers a similar process of demythification.

In Amor y ciencia we have seen that Galdós' conception of the scientist is that of a humanitarian figure, a man who serves mankind and leads them to both spiritual and material progress. The scientist applies his knowledge for the betterment of man. Galdós makes this clear by choosing a doctor to represent science, for medicine is the discipline with the most obvious positive benefits to man. In Tiempo de silencio, however, science has lost this utility. Pedro is a researcher whose work does little to benefit his fellows. The world of the lab is completely separate from the world of the chabolas.

The scientist is not only incapable of helping society, he is also incapable of helping himself. The rational habits of mind Pedro has acquired as a result of his profession do not even help him solve his own individual problems of alienation and estrangement. Indeed in several passages Pedro refers to "su propio racionalismo mórvido" (pp. 62, 238) and in periods of crisis -- in jail and after Dorita's death -- Pedro admonishes himself "Para qué pensar. No hay más que estar quieto. No pensar en nada....Saber que no pasa nada grave, que no hay más que esperar en silencio...no pensar" (p. 175). In these moments of despair Pedro actually suppresses his rational processes for he knows intuitively that they are incapable of helping him.

Reason then is no longer seen as the tool the scientist uses to penetrate the mysteries of the universe and then to guide his fellow-
men towards happiness. Reason is useless. Reason does not help Pedro to guide the destinies of others; indeed it does not even help him to direct his own destiny. He is powerless before circumstances beyond his control—Florita's abortion and his chance involvement in it, Dorita's murder, etc.

Pedro's exile to the provinces is the final symbol of his powerlessness— he cannot even cry out in protest. As Ricardo Domenech points out, this sense of impotence is very important, for Pedro comes to symbolize twentieth-century man in general:

Esa marcha final de Don Pedro hacia una lejana ciudad de provincias nos parece una de las cosas más serias que se han escrito sobre la derrota de un hombre. Este personaje patético que es Don Pedro viene a simbolizar también, pues, toda una época, la suya propia, su tiempo de silencio.23

Man is suddenly seen to be alienated from others and forced to face life alone. The old faith in rationalism and science is gone. Even the scientist cannot derive help from science and reason. This same vision of aloneness and alienation continues in Daniel Sueiro's Corte de corteza, but in this anti-utopia the vision is even more pessimistic. Not only is science incapable of helping man, science is actually destroying him.

Corte de Corteza is set about twenty years in the future, towards the end of the 80's. Mankind has succeeded in building utopia. Medical science has conquered cancer, and is now capable of transplanting any of the body organs and of creating and modifying life in the test tube. Technology has developed the means to predict earth-
quakes and similar disasters and to harness their destructive energy for man's benefit. Applied technology has almost eliminated automobile accidents. Cars now move by remote control along magnetized highways, passing even under the Atlantic and the Himalayas. A universal language seems to be forthcoming; international frontiers and customs have already been abolished.

But Corte de corteza represents an Orwellian vision of utopia. This utopia is no earthly paradise. The world is ruled by totalitarian states, torn by continual warfare. In order to manipulate individuals, the state resorts to thought control. Organizations like "Future's Key" dictate what people need and buy:

Realmente, la compañía de Key no fabricaba nada, pero lo vendía todo, ese era su lema. Su estado mayor de estrategas y sicólogos ejercía un absoluto dominio sobre el consumidor interior y sobre los métodos para asegurarse en cada caso los recursos absolutos de aprovisionamiento y también las técnicas de ventas, merced a las cuales conseguimos hacer necesario lo superfluo y sabemos hacer viejo lo nuevo en cuestión de semanas. Nunca hay riesgos así. Con lo cual los negocios son seguros, el país progresa y los hombres y sus familias viven cada vez mejor, qué duda cabe, dominando las cosas, utilizándolas y tirándolas para volver a comprar otras, persuadidos de que eso es lo mejor que pueden hacer en esta vida.24

Key and his fellows even bribe foreign ministers to introduce their products and make their use obligatory.

The mass media too is used to mold public opinion. As one photographer puts it:

Lo que nosotros filmamos y ponemos ante vuestros ojos es como si realmente estuviera hecho
por nosotros mismos. Cortamos el celuloide o lo unimos donde nos parece y nos conviene, podemos poner aplausos donde hay gritos e insultos, sonrisas donde debían verse lágrimas. Hemos hecho a varios Presidentes, el último por cierto el más fotográfico de todos y salido de nuestras mismas líneas profesionales, hemos provocado conflictos internos y guerras internacionales, elevado la moral del país o conducido al suicidio a más de un indeseable. Podemos cambiar lo blanco en negro en veinticuatro horas, y luego devolver el color blanco a lo que acabamos de convertir en negro en menos de una semana (p. 140).

The individual is constantly overrun by technology and exploited by scientists while governmental propaganda campaigns persuade him it is all for his own good and the progress of mankind. Sueiro uses the professor Adam to symbolize this destruction of the individual in the midst of the technological utopia. Adam, as his name implies, represents all men. Intellectual and sensitive to the destructive climate around him, Adam has a sense of impending doom and speaks out against the tyranny of words which he feels is leading to destruction. He advises his students:

...no escuchéis ya una sola palabra de nadie sin tratar de estudiarla profundamente, de desmenuzarla en sus más pequeñas partículas, de sicoanalizarla fría y duramente, sin destruirla al fin e ignorarla una vez desentrañado su malévolo, pérfido, opresor y aniquilante significado (p. 46).

Adam is wounded in a mysterious street shooting and taken to one of the world's leading medical centers. There, in spite of the fact that the liver transplant which would save him is now commonplace, Adam is told that it is impossible in his case. His only hope of
salvation lies in allowing his brain to be transplanted into another healthy body. David Davis is conveniently dying of a brain tumor and would be the ideal donor. The doctors argue with Adam, using the same deceptive words Adam despises to convince him that he should submit to the transplant. You are, after all, they say, only your mind, housed in a frail corporeal support. Your body is not essentially you, why not change it for another so that your mind, your essential being may go on living?

The doctors, of course, use a different argument to persuade David Davis and his wife of the desirability of the transplant. Why die, they say, merely because one organ is damaged? Your body — the most important part of you, naturally — is in magnificent condition. It merely needs a new driving force, a new brain.

Neither Davis nor Adam ever actually consents to the operation, but as the author points out, their consent was really irrelevant. They had signed the necessary legal documents before being admitted to the hospital. The transplant is performed and is technically a great success. It is publicized as medicine's conquest of death, optimistic news intended to divert attention from the war and other more pessimistic considerations.

For Adam himself, however, the operation marks the beginning of the end. In spite of the fact he had been told that the operation was the only way he, Adam, could go on living, teams of psychologists, sociologists, and scientists now strive to persuade him to take on the identity of David Davis and to re-integrate himself into Davis's life,
not his own. David Davis is Adam's opposite. Where Adam is an intellectual rebelling against the language of deceit used by government and advertising, Davis is an anti-intellectual athlete working for Future's Key, one of the principal propaganda agencies. Adam resists being made over in Davis' image, but he does not know that his mind is no longer his own. His emotions and reactions are being controlled by means of tiny electrodes implanted in his brain during the transplant operation.

Adam attempts to live with Davis' wife for a time and to accept his life, but is unable to do so. He begins his old teaching anew from an underground radio and becomes more and more revolutionary exhorting all who will listen:

No aceptéis jefes, presidentes, directores, sacerdotes ni padres, sean de la clase que sean; vosotros sois vuestros Únicos jefes, vuestros Únicos salvadores. ¡Y no espereís más: daros la libertad! Todo se puede imaginar y todo lo imaginable es posible (p. 376).

He advocates, in short, the destruction of utopia. But he soon finds he is beginning to lose his memory. He is beginning to forget words and is losing some of the co-ordination on one side of his body. When he speaks of this to Castro, the one rebel doctor he feels close to, Castro realizes that the chief surgeon Blanch and the other doctors are destroying his mind as part of the transplant experiment. Castro asks them to help Adam while there is still time; when they refuse, Castro dies mysteriously in an automobile accident. It is implied that he commits suicide.

Adam is unable to carry on his struggle against the destructive world around him and he too commits suicide. His suicide is symbolic of course. It represents man's last act of defiance, the last
exercise of his free will. He will destroy himself rather than allow himself to be destroyed by others. When the police agent blows his brains out, Adam is already dead.

*Corte de corteza* obviously presents quite a different conception of utopia than that advocated by Bacon three centuries ago. The conception of science and the scientist has also changed drastically from the Baconian conception still current a century ago. To appreciate the magnitude of this change we need only compare Guillermo, Galdós' scientist hero, with doctor Blanch, the principal representative of science in Sueiro's novel. In our study of *Amor y ciencia* we noted that Guillermo was the embodiment of ideal virtues — love, humanitarianism, wisdom — and he served mankind, leading man to both material and spiritual betterment. Doctor Blanch, on the other hand, is portrayed throughout Sueiro's novel as the embodiment of evil. He no longer uses science to serve man, but instead sacrifices man in the service of science.

Our initial vision of Blanch sets the tone for his entire characterization. As Blanch emerges from the helicopter his assistants watch him approach:

Como a una extraña aparición fantástica, casi irreal, un ser mágico o providencial literalmente caído del cielo, envuelto en su capa...una ligera sonrisa en los labios finos en medio de su afilado rostro, y especialmente aquellas dos puntas de diamante o de hielo líquido en medio de los ojos claros inmóviles que nunca parpadean ni sorifen (p. 158).

Sueiro continually refers to Blanch as "mago" and emphasizes the aura of mystery that surrounds the man: He never sleeps; his favorite
apparel is a black cape which covers and hides him; he makes mysterious
journeys, etc. Blanch is always linked to a world of evil over which
he presides as a sort of Satan figure. His palatial country home is
a bestiary where he conducts grotesque experiments on plants and
animals. Sueiro even suggests his unnatural experiments also use human
subjects. Blanch's evil is further linked to the power of the totali-
tarian state. He courts and flatters the all-powerful president and
it is implied the state will use his transplant technique in its
espionage activities. The implication is clear: science and the
scientist, allied with the totalitarian state which is the logical
development of either the Orwellian or Marxist type of utopia, create
an environment which is intolerable for the individual. Science can
indeed create utopia, but this utopia is more to be feared than
desired.

Throughout the twentieth century we have seen a reversal of the
optimistic attitude towards science which was generally prevalent in
the three preceding centuries. Unamuno and other members of the
Generation of '98 argued that reason and science were not superior to
life. In Amor y pedagogia Unamuno attacks the overemphasis on reason
which he feels will destroy the individual. The fight against the
domination of science and reason was given renewed impetus in the
first quarter of the century by developments within science itself
which demonstrated that it was not infallible. Many of the rational
concepts on which the discipline had depended were proven to be in-
valid and scientists were forced to admit that theirs was not a
discipline capable of discovering any ultimate truth.

This crisis in confidence in science was accelerated by the world wars. It was impossible to be optimistic about the application of science in the face of the destruction wrought by war. The wars also stimulated a tremendous acceleration in technology which gave rise to new fears. To many, it seemed that technology was destroying the individual. George Orwell voiced this fear in 1984 and in Spain today Orwell's influence is obvious in writers like Daniel Sueiro who are re-examining the idea of a scientific utopia. Sueiro's verdict is clear: a utopia run by scientists will destroy man. This view is shared by many other contemporary writers. James Garrett writes: "It would appear in retrospect that the tendency of utopian fantasy in our time is towards a fear of utopia itself."25 We have thus come full circle, from Francis Bacon's New Atlantis proclaiming faith in human progress and the desirability of creating a utopian society directed by science to Daniel Sueiro's anti-utopian novel expressing the twentieth century's loss of faith in science and fear of utopia itself.
1Will Durant, The Story of Philosophy, p. 206.
2Ibid., p. 208.
3Ibid., p. 308.
5Ibid., p. 1107.
6As quoted by Ritchie Calder, Man and the Cosmos, p. 25.
7J. Bronowski, The Common Sense of Science, p. 80.
8Ibid., p. 85.
9Pedro Lain Entralgo, La generación del noventa y ocho, pp. 69-70.
10Miguel de Unamuno, Amor y pedagogía, p. 10. All future page references are made to the edition cited in the bibliography.
12Ibid., p. 30.
14Barnes, op. cit., p. 1218.
15Hudson Hoagland, editor, Evolution and Man's Progress, p. 88.
16Barnes, op. cit., p. 1322.
17Ibid., p. 1086.
18J. C. Garrett, Utopias in Literature Since the Romantic Period, p. 49.
19Ibid., p. 59.
22 Luis Martín-Santos, *Tiempo de silencio*, pp. 44-45. All future page references are made to the edition cited in the bibliography.


24 Daniel Sueiro, *Corte de Corteza*, p. 81. All future page references are made to the edition cited in the bibliography.

LITERARY STYLE: ITS CONTRIBUTION TO THE STUDY OF THE RELATIONSHIP BETWEEN SCIENCE AND LITERATURE

By examining some key works of Spanish fiction, we have seen that the kinds of explicit and implicit statements their authors make reveal a dramatic change in the Spanish attitude towards science from the eighteenth to the twentieth centuries. Our study of these works has been largely limited to examining the ideas they express, that is, to a study of their content. But we must remember that all of these works are pieces of fictional literature, not mere essays expressing ideas. As works of art their style has a conceptual value which is just as important as their content, and so to complete our study we must also examine the style of these works. As Bronowski says:

Just as the changes in outlook since the Renaissance have affected the content of what men think and write, so they have affected the manner in which they think and write. The style of a man or of an age mirrors the thought....

We have noted that Cadalso writes his Cartas Marruecas in the epistolary form. We might well ask now why he chose this style and what significance his choice of the letter form holds for our study of the relationship between literature and science.

The epistolary form furnishes an ideal vehicle for social criti-
cism. It frees the author from the necessity of developing plot or characterization and allows him to deal instead with any aspect of society which interests him. There need be little logical connection between the letter sequences; the letter form itself provides a sort of unity for the work. Thus the author's entire attention may be centered around his criticism of society; he need waste little time with the elements of plot, characterization, transition and unity which occupy such a prominent position in the traditional novelist's work.

The letter form is also admirably suited for displaying the satire which is so often a part of social criticism. We have seen that Cadalso uses his letters as instruments of satire in his portrayal of the scholastic educators and traditionalists who obstruct reform. Both this use of satire and the epistolary form are, as Bronowski and Mazlish note, characteristic of the "new style" that arose after the Scientific Revolution:

The new style, in fact, had a particular leaning to satire, and was used in this way almost at the beginning of the Scientific Revolution by Galileo in his Dialogues. The dialogue form also lends itself particularly, as Socrates had shown many centuries before, to that method of questioning the accepted nature of things which Descartes consolidated into the philosophical method of doubt. In satire and in dialogue, the method of doubt expressed itself in the masterpieces of French literature before the French Revolution, in the hands of Pascal, Voltaire, Montesquieu, and even Beaumarchais. Just as the philosophes put the new ideas of science and secularization into the content of the Encyclopedia, so the writers displayed them by their very style.2
Cadalso was familiar with these French authors and, like many of his contemporaries, was attempting to situate in his own terms the literary and ideological models offered by writers of the French Enlightenment. It is generally conceded that Cadalso modeled his Cartas after Montesquieu's Lettres persanes. Yet it is also usually acknowledged that the connection between the two works is largely limited to their external form. As Hughes notes: "Both criticize the national realities with which they are concerned, but with totally different 'intents,' and 'literary consequences.'" These differences are of significance for our study. The two authors approach the national realities with which they are concerned in fundamentally different ways. Montesquieu subjects his country to an objective analysis and in his criticism exposes its customs and institutions to devastating satire. Nothing is immune to his wit. There is no institution too sacred, nor popular belief too widely held to dissuade him from his critical purpose. He has extensive satirical treatments of both government and religion, institutions Cadalso would not think of criticizing. Montesquieu writes from his intellect. His point of departure is a neutral, scientific and dehumanized view of the universe. His reason is not inhibited by any of the traditional and religious preconsiderations that made the elements of "lo esencial" immune to Cadalso's criticism. For Cadalso monarchy, religion, and elements of the essential Spanish tradition are constant factors in the life of the nation, and not subject to change.

Unlike Cadalso, Montesquieu was not searching for the true
"caracter nacional" but contented himself with describing and criticizing the existing social order. He did not write from any national preoccupation but rather like the other philosophes from a desire to exercise his reason and display his wit.

Despite the severity of his criticism, Montesquieu does not dispair of France. Her faults and her virtues are united for him to form what he will later call her 'espirit national.' Behind his judgements France appears as an imposing structure, impervious to anything he may say. His words reveal an admiration for his country, exactly as he knew her, which he makes no attempt to conceal. He looks neither to a mythical past nor a morally renovated future for a solution. Indeed no solution is necessary. France as France is not a problem to Montesquieu.

Cadalso, we remember, did write from such a national preoccupation. The realization that Spain was being left out of the important intellectual currents of the Enlightenment and was deficient in the new sciences caused Cadalso and his fellow reformers to examine the national conscience in search of the reasons for Spain's backwardness. Yet we have seen that Cadalso was interested in reforming only "lo accidental," the external and in no way essential aspects of Spanish life. For him, innovations were acceptable only if they did not impinge upon "lo esencial," the essential Spanish tradition rooted in the Catholic faith and the monarchy. The fact that Cadalso, unlike Montesquieu, is motivated by a national self-critical preoccupation, and places strict limits on the aspects of national life in which he will permit reform partly predetermines his choice of the foreign traveler whose letters convey the author's social criticism. Montes-
quieu's letters were supposedly written by a Persian traveler, an exotic Eastern visitor whose customs and traditions were entirely foreign to France. Cadalso, however, chooses a Moor -- a foreigner to be sure, yet a foreigner whose national traditions form a part of Spain's past. This choice would seem to suggest that although Cadalso wanted to create the impression of an impartial judgement of his nation, he was also anxious that she not appear opposed to tradition, for as Ximénez de Sandoval notes:

...las cartas entre los dos moros, y aún las tercerfas del español Nuño, albergan, es cierto, una crítica ilustrada y progresista de las cosas de España, pero también una defensa y afirmación de muchos de nuestros fundamentos morales.5

A Moor could perhaps be expected to judge the essential Spanish traditions a little less harshly because of Spain's past relationship with his own country.

We can thus see that Cadalso's choice of the epistolary style was conditioned both by the critical spirit of his times and by his own literary intent. We might well now ask what his choice of this form can tell us about our theme -- what can Cadalso's choice of literary form tell us about his implicit feelings toward the new sciences?

Cadalso's use of the epistolary form establishes a certain distance between the author and his work, for the writer actually denies his own authorship. Cadalso does not approach his subject directly and personally, but rather through the intermediary of the objective
foreign traveler. The real author, therefore, does not display much emotional involvement with his subject. Neither does he deal with his own personal preoccupations. It can, of course, be argued that through Nuño Cadalso does express a great deal of anguish concerning Spain's decadence, but this anguish is not merely personal. It is, rather, social in nature. For Cadalso, the personal and social are nearly one. His personal anguish is the anguish of Spain; her problems and his are one and the same. Thus we might say that Cadalso thinks of his dilemma as being social rather than individual.

For Cadalso, science has not yet raised personal problems. He sees no conflict between science and morals or between science and religion. In his thinking, science and religion and morals still belong to two separate worlds -- science to "lo accidental," religion and morals to "lo esencial." Science has not yet upset intimate religious beliefs or occasioned personal anxieties. The new sciences have merely upset the social order in Spain, forcing the nation to make social, economic and educational reforms in order to adapt herself to the changing climate created by the Scientific Revolution.

The important point to be emphasized here is that Cadalso's choice of the letter form underlines the fact that he felt the problems created by the advancing sciences to be social rather than individual. He therefore chose a style that would allow for maximum social criticism with a minimum of personal expression. As advances in science begin to effect essential personal and religious sentiments, we will see authors begin choosing different literary styles that
allow them to express individual feelings of anguish and alienation.

The tendency towards national self criticism we have seen in Cadalso continues in Galdós where it finds its most obvious expression in El caballero encantado. Like Cadalso, Galdós uses the observations of a traveler to convey his social criticism; but he chooses a Spaniard, traveling in his own land, rather than a foreign traveler. And the criticism is expressed through the direct experience of the traveler rather than by means of his letters. The novel is written in the style of the "libros de caballería." The protagonist, Tarsis, moves in a world of enchantment and magic and participates in a series of adventures like the typical chivalric hero. Galdós constructs his narrative with careful adherence to the tradition of the "novelas de caballería." Like the typical chivalric writer, he denies his own authorship of the work, saying that the narrative he presents was contained in an old chronicle, etc. And like the older authors he uses the traditional narrative formulas ("conocerás el que tenga paciencia para seguir leyendo," etc.) to introduce his adventures.

Galdós' choice of the chivalric style has several advantages. Firstly, it establishes a certain unity between the style and the content of the work. The novel itself is Galdós' most obvious attempt to discover "...lo que España es en realidad o ...lo que constituye la realidad española." It is highly appropriate for Galdós to write the novel in the chivalric style, thus establishing a link between his work and Cervantes' Quijote, usually considered the most typically Spanish work of the national literature. Even the style of Galdós'
work is rooted in Spanish tradition and contributes to his discovery of the reality of this tradition.

Galdós' choice of the chivalric style secondly makes possible the use of enchantment and magic which further contributes to the discovery of the essence of Spanish reality. Magic allows Tarsis to cross the boundaries of time and space in his exploration and discovery of the true Spain. As Gustavo Correa notes:

El ambiente de magia y encantamiento que preside su itinerario constituye una vía para penetrar más a fondo en el interior de la realidad, a fin de conocer sus más íntimos secretos. El Tarsis encantado se sitúa de esta manera en la raíz misma de lo hispánico y logra asimismo penetrar en el fondo de sus esencias culturales.

Thirdly, the choice of the "novelas de caballería" form allows Galdós to use the framework of many loosely connected adventures throughout the body of his work. This format of a series of adventures has several advantages. Since the network of adventures found in the chivalric novels characteristically have little relationship to each other, the adventure structure gives Galdós the same freedom the epistolary form offered Cadalso -- he can allow his protagonist to participate in a variety of adventures among all levels of society without having to be unduly concerned with establishing a logical unity between these separate adventures. The device of having his hero participate in a series of adventures which, through the medium of magic, explore all of Spain in both time and space is therefore admirably suited to Galdós' central theme of social criticism.

Through the use of the chivalric adventure series Galdós is also
able to establish his concurrent theme of the progressive education of Tarsis to be a better Spaniard. Tarsis' adventures constitute a symbolic educative journey:

...en el Caballero encantado, con su característica atmósfera de un mitológico devenir, la peregrinación del caballero Tarsis, a través de la geografía y de la historia de la nación española, y su final sumerición en las aguas del Ebro, tiene el sentido de una experiencia purgativa, realizada en el interior de la conciencia. El protagonista emerge, finalmente, del fondo abismático de su personalidad, con el espíritu transformado y el corazón dispuesto a emprender un programa de verdadera regeneración para su país.

Let us again outline briefly the chief steps in this symbolic journey. Under the guidance of La Madre, the true spirit of Spain, Tarsis works first as a manual laborer. Correa notes that:

Como trabajador del campo se pone en vinculación directa con la tierra y en su condición de pastor descubre un oficio que es frente permanente de honra y paz. La sociedad paradisíaca de los pastores, en la cual sus miembros alternan fraternalmente los unos con los otros, le permite a Gil soñar en un 'mundo patriarcal', habitado por seres inocentes que no viven más que para compartir con amorosa equidad los frutos de la tierra.

But Tarsis is made to see this fundamentally utopian vision of life in continual contrast to the harsh reality of rural Spain. Boñices and other country towns Tarsis visits are incredibly poor and Galdós describes them in terms suggestive of human sepulchers. This contrast between the vision of life as it could be and life as it is makes Tarsis realize the necessity of reform.

At the same time the vision of the Spanish present is contrasted
with that of the glorious Spanish past as La Madre leads Tarsis to Numancia and other sites enshrined in his national history. Here Tarsis learns of his past and develops a reverence for the essential Spanish tradition, thus assuring that any reforms he undertakes will be firmly rooted in this tradition.

Concurrently with his education in history, La Madre leads Tarsis through a series of exercises designed to strengthen his moral character — his rivalry with Regino, love for Cintia and encounters with don Gaitán all play important roles in this moral re-education which culminates in the "cura de silencio." At the conclusion of Tarsis' educative journey he is symbolically baptized in the waters of the Tajo, emerging with a firm resolve to work for the betterment of his nation.

It is important to emphasize that Galdós endows Tarsis' educative journey with a social function. Throughout his journey Tarsis not only learns about Spanish society, but he also becomes progressively integrated into this society as he is led to accept his social responsibility. He ultimately finds his own individual happiness in fulfilling a social function — that of a teacher who will teach others the lesson he has learned. Cintia too undergoes a similar process of social integration. We will remember that as Tarsis first tries to flee with Cintia, their escape is blocked when the children Cintia is teaching hang on to her, refusing to allow her to leave. The children, of course, symbolize Cintia's social responsibility. The two lovers are acting selfishly, thinking only of themselves and
disregarding their obligations to the society of which they are a part. As long as they maintain this selfish perspective, their love cannot attain fulfillment. After some reflection, Tarsis comes to the conclusion that

para poseer la persona de Cintia, como poseo su alma, mi conducta debe ser otra. En vez de arrebatarla, separándola de la crianza mental de los niños, procederé más cuerdamente haciéndome yo también maestro y asociándome a su labor, para que, en perfecto himeneo de voluntades, de corazón y de oficio, vivamos juntas consagrados a la misma obra santa.10

He accepts his social responsibility. His next attempt to escape with Cintia is therefore successful. At first the children try to restrain Cintia as before, but when she says, "Dejadme, ángeles míos. Volveré con vosotros," the children fall to the ground as if charmed and she escapes while they sleep. Once she has accepted her social obligations, vowing to return to the children, she is allowed to join her lover.

For Galdós, it would seem to be impossible for the individual to attain happiness outside of the social framework. Individual and social welfare are one -- the individual finds happiness serving society. The individual is often led to happiness within the social context through the medium of love. In Tarsis' case, once he is able to love and accept feelings of responsibility and concern for Cintia, he becomes able to broaden this concern for others to embrace all of society. We see this same pattern in the love Paulina develops for Guillermo in Amor y ciencia.
In the beginning of the work, Paulina is living a very selfish life, acting only in her own interests. With her love for the arts and theater, she symbolizes the artistic and imaginative qualities of life. But in Paulina these qualities serve only her own selfish ego; they do not contribute to the social good. It is only through her growing love for Guillermo that she comes to see her social responsibility and finally vows to aid him in his work. Her acceptance of her social role marks a sort of conversion for her. Her name is perhaps symbolic of this conversion for it alludes to the greatest of Biblical converts, St. Paul. The reconciliation of Paulina and Guillermo brings about the union of the different qualities they symbolize — the artistic and imaginative qualities of Paulina and the scientific, rational qualities of Guillermo. The two then direct their combined energies to the service of mankind and in so doing attain happiness. This service too has Biblical echoes, for they found a utopian community based on the principles of love St. Paul preached so eloquently. Guillermo's role as a doctor has actual and symbolic meaning. He is ministering to his fellowman. He not only cures their physical ills, but also, through his teachings and his example, cures their spiritual sickness, showing them how to live together in fellowship and love.

Both _El caballero encantado_ and _Amor y ciencia_ are highly symbolic works. Galdós endows almost every character and every event with symbolic meaning. Indeed, there are few other works in which Galdós carries the process of symbolization to this degree. We must ask why he chooses this style for these two works in particular.
It would seem that the act of symbolization creates a certain distance between the author and the reality he describes. In this respect Galdós' use of symbolism can be seen as basically similar to Cadalso's use of the letter form. Both styles enable their authors to establish distance between themselves and their subjects. They do not describe the reality they are concerned with directly, but rather through the medium of the fictitious letter or the literary symbol. Both authors use these devices for social criticism precisely because they do establish this distance between the author and his subject. They allow the author to withhold his own personal emotions and instead to speak in social terms, indicating that he is still seeing the problems created by the new sciences as being social rather than individual in nature. Galdós as yet sees no great crisis for the individual as distinguished from society as a whole. The social and individual welfare are still one and the same. Thus we see that by working for the social good Galdós' characters themselves find happiness. Since the problems raised by science are social, they may be cured by the social reforms -- reforms of the educational system, etc. -- that Galdós advocates.

In Galdós we see also that science and religion or morals are united, and together they work for the social good. This union is particularly evident in the person of Guillermo in Amor y ciencia. For Galdós there is of yet no conflict between science and religion or between science and morals. Instead, he is able to reconcile the new sciences with the traditional religious and moral values. Such
reconciliation becomes impossible for many later writers, and beginning with the generation of '98 we see science and morals dividing and often conflicting.

This division between science and religion and morals is evident in Unamuno's *Amor y pedagogía*. Here one of Unamuno's central concerns, as revealed particularly in don Fulgencio's monologues, is the conflict between religion and science and the state of agony which results when reason and science begin to overturn the religious concept of personal immortality.

In *Amor y pedagogía* Unamuno repeatedly develops the idea that science or reason is useless in questions concerned with ultimate transcendental values. Science cannot show Apolodoro how to love or how to be happy. Unamuno's viewpoint of course contrasts sharply with Galdós' vision of a science endowed with a moral purpose which leads man to love and ultimate happiness in serving his fellows. Indeed this very idea that man can achieve happiness serving his fellowman brings us to another major difference between Unamuno and Galdós.

In Galdós' works, we have said that the individual and social welfare are usually one and the same; what benefits society benefits the individual and vice versa. Individuals achieve personal fulfillment while working for the social good. In Unamuno, however, we begin to see a division between the individual and society. This division is evident in one of the last dialogues between Avito and his son:

- Tenemos que hablar, Apolodoro.
- Tú dirás.
- Observo en ti desde hace algún tiempo algo extraño y que
cada vez respondes menos a mis esperanzas.
- No habérlas concebido.
- No las concebí yo, sino la ciencia.
- ¿La ciencia?
- La ciencia, sí, a la que te debes y nos debemos todos.
- ¿Y para qué quiero la ciencia si no me hace feliz?
- No te engendré ni crié para que fueses feliz.
- ¡Ah!
- No te he hecho para ti mismo.
- Entonces, ¿para quién?
- ¿Para la humanidad?
- ¿La Humanidad? Y quién es esa señora?

With Unamuno we begin to see emphasis shift from the social to the individual. We see the individual apart from society, alienated from it. The individual can no longer receive help from society or from social institutions. He must solve his own problems, and he must solve them alone.

Apolodoro's alienation develops as a direct result of his father's attempts to make him into a totally rational, scientific man. Instead of producing the genius he had hoped for, Avito's efforts succeed only in producing an individual who is miserably isolated from his fellows and unable to cope with the world around him. The rational approach his father has instilled in him is not only ineffective in helping Apolodoro answer life's important transcendental questions, it also alienates him from others. Avito's teachings make Apolodoro an intellectual oddity, unable to communicate with others who have not been forced into the impossible situation of trying to live only according to the dictates of reason.

This shift in focus from the social or the individual in harmony with society to the alienated individual is accompanied by corresponding
changes in the literary form Unamuno uses to express his ideas. In *Amor y pedagogía* Unamuno chooses a symbolic style which reminds us of Galdós' use of symbolism in *El caballero encantado* and *Amor y ciencia*. Even the title of his work echoes the Galdósian drama. Unamuno uses Avito and Apolodoro as symbols for science and love or the vital forces in much the same way as Galdós had used Guillermo and Paulina. One feels that perhaps Unamuno, like Galdós, chose to write using the medium of symbols in order to put distance between himself and his theme. Unamuno is, after all, writing a type of social criticism -- a criticism of the dominant role of science at the expense of the vital -- and he perhaps felt this use of symbols would enable him to create an impression of greater objectivity in his criticism. It had, we remember, created this effect in Galdós. But Unamuno, unlike Galdós is not able to maintain any appearance of objectivity. He seizes his symbols and makes them the mouthpieces for his own personal anxieties. Apolodoro and don Fulgencio echo Unamuno's fears and emotions; indeed many of don Fulgencio's anguished monologues expressing the desire to live eternally as "un hombre de carne y hueso" seem to be torn from the pages of *Del sentirimento trágico de la vida* where Unamuno voices the same tormented yearning.

Unamuno is incapable of maintaining any sort of objectivity simply because the problems he writes about have ceased to be merely social problems. They are now his own intimate problems and he cannot keep his personal feelings from coloring his writing. It was relatively easy for Galdós to maintain an objective viewpoint in *El caballero*
encantado as he symbolically wrote of the need for a new education. But then it was really not his problem. It is quite another thing for Unamuno to maintain this same degree of objectivity while discussing science's destruction of all the religious and vital forces he valued in life. The problem has become much more intimate and personal. Unamuno's extensive use of dialogue and the extended monologue is indicative of this loss of objective distance between the author and his subject. Once Unamuno begins expressing his own feelings he resorts to long monologues as the form most appropriate for this expression. These extensive monologues are, on the other hand, almost completely lacking in Galdós' more objective narrative.

The causes of Unamuno's inability to harmonize science and reason with religion and morals can perhaps be found, as we have indicated, in the history of science. Briefly, the late nineteenth and early twentieth century saw tremendous advances in science and technology. A drastic reforming and restructuring of society and its institutions was necessary to keep pace with the changes wrought by science. In literature we see the need for this reform emphasized by writers like Cadalso and Galdós. But attempts to implement needed reforms generally failed. Barnes notes that looking at the problem in a broad and general way, one can accurately say that the fundamental reason for the development of what we may call the Orwellian pattern was the frustration of institutional reforms -- social, economic, and political....

Advances in the physical and natural sciences were not accompanied by
similar advances in the social sciences which might otherwise have served to guide society in adjusting to change. The failure of the reform movements and the social sciences to keep up with scientific advances produced cultural lag which had the effect of throwing man entirely on his own resources. He could no longer turn to the social institutions which had formerly offered him comfort and guidance. Science seemed to be overthrowing religion, the source of divine guidance; and the social sciences which might have offered guidance of a more secular sort were proving themselves totally inadequate. Science seemed the only certainty. Indeed, faith in the power of science to at last unlock all mysteries replaced faith in religion for many. But even this faith was soon destroyed by the twentieth-century revolution in physics. Where was man to turn?

Thus the advancing sciences first created social problems as men saw the need for changes in educational, economic and social institutions. We see this stage reflected in the works of Cadalso and Galdós. But the reform movements failed and social institutions soon became hopelessly antiquated. Change swept on to engulf individuals, forcing them to cope without the help of traditional institutions. The problems produced by scientific change become more personal. The question is no longer how to reform the educational or economic system but rather how to love, how to have faith, how to live as an individual in a technological society that tends to destroy love, faith and the individual. In his lonely struggle to cope, a struggle which is of necessity carried on outside of traditional institutions,
the individual is seen as alienated -- so totally alienated that he is frequently led to self destruction. We see this vision of the alienated individual beginning in Unamuno, and continuing and intensifying in the contemporary novels. 

In our study of Tiempo de silencio we noted that the style of the work is of primary importance. Martfn-Santos favors a language full of technical, medical and psychiatric terms, neologisms, and anglicisms. In general he tends to employ unusually long sentences and paragraphs which are sometimes deliberately archaic and reminiscent of Latin constructions. Sustained metaphors abound. In his use of all of these stylistic techniques he is "...striving to create rather than copy reality, to present it not only externally but also internally ('desde dentro')...."^3 This attempt to create a new reality requires a new style, for any vision of reality is inherently linked to the style in which it is expressed. One notices this renewed emphasis on style and the literary creation of new realities in many contemporary novels, and it would not seem totally unfounded to postulate a possible relationship between this trend in literature and the contemporary scientific revolution in physics. For as Sherman Eoff notes:

...modern physics encourages the imagination to construct new concepts of reality. With the undermining of time and space as absolutes in themselves, it is no longer necessary to look upon things and persons as lumps of reality inhabiting concrete, localized areas. Instead, time, space, and things are merged into one, and we are obliged to depend heavily upon abstract mental constructions in our search for new meanings."14
For our study Martín-Santos' use of the "monólogo dialéctico" deserves special attention. This form allows the author to penetrate the individual psychology of his characters without himself intervening in the first-person narration. The "monólogo dialéctico" thus combines interior monologue with the objective narration of exterior action so as to convey the impression of the character's simultaneous awareness of his own subjectivity and of external events. Throughout the novel:

The characterization, in first person, is done from within the consciousness of the several characters, whose monologues reveal their internal weaknesses and contradictions, their self-deception or vacillation, but interpretation and organization of these data are left to the reader. Most expository detail is conveyed by these same monologues ("realidad desde dentro") while action is presented indirectly via the consciousness of one of the characters or narrated briefly and rapidly in the third person.15

Martín-Santos' conception of contemporary reality can best be seen in the person of Pedro, the principal narrator, protagonist and central consciousness of the novel. Pedro's prime characteristic, as shown by the narrations, is his alienation, his complete inadequacy in dealing with his environment.

Pedro's alienation is revealed in the style of the narration itself. There is little direct dialogue. When dialogue is used it usually paradoxically underlines the fact that no real communication is taking place. Note in this respect the dialogue between Pedro and the policeman (pp. 195-99). Pedro is unable to communicate with others; his attempts to do so usually result in misunderstanding. This lack
of meaningful communication creates a climate of alienation. The narrator's continual use of dehumanizing epithets reinforces this atmosphere of human estrangement. The narrator continually refers to people as categories or as things or animals: Pedro's fiancée, her mother, and grandmother are referred to as "the first, second and third generation;" a girl in a café becomes merely "the yellow blouse;" at a gathering of intellectuals people are described as birds in an aviary; doña Luisa is a queen bee, etc.

Pedro's alienation seems to be a direct result of his scientific, rational habits of mind. This scientific approach leads him to make faulty judgements as we noticed in his impression of the chabolas. It also tends to alienate him from others, for it prevents him from ever seeing another person directly as a human being worthy of communion. He sees all others as scientific cases and looks upon them as illustrations of textbook theories from both the social and natural sciences.

This scientific approach is illustrated in the narrator's reference to Dorita as "la tercera generación." Even though Pedro is intimately involved with the girl, he continues to see her as one generation in a sociological study of a particular family. This same tendency to see everything in scientific terms prompts him to make the comparisons between human and animal societies we have noticed above. Pedro converts everything to the language of science. The result is a complete disjunction with his environment. This is conveyed by the entire thematic content of the work. And it is also
subtly conveyed in the style of the narrator who uses the language of the report, full of scientific and technical jargon, throughout the work. In many instances -- such as the description of the "vertical burials" -- this style is highly inappropriate for the subject matter being treated. This disconformity between the narrator's style and his subject matter only serves to underscore Pedro's fundamental inadequacy. The narrator's language reflects Pedro's scientific approach to life; the resultant incongruities directly mirror Pedro's disjunction with the world around him.

Once again we notice that Martín-Santos, like Unamuno before him, focuses on the individual rather than the social nature of the problems created by the advancing sciences. And like Unamuno, the author of _Tiempo de silencio_ chooses to write large portions of his work in a form of the monologue, the literary style which perhaps offers the greatest possibilities for the analysis of individual psychology. The literary distance we experienced in Cadalso and Galdós is gone. We find ourselves being thrust into the anguished consciousness of the characters. The anguish of characters like Avito and Pedro, of course, in turn reflects the anguish of their authors and twentieth-century man in general, for it is clear that these characters are meant to be understood as universal symbols.

We should note that unlike Unamuno, Martín-Santos seems to see no direct conflict between science and religion or morals. Pedro, the scientist, is engaged in a moral and humanitarian pursuit as he searches for a way to cure cancer. Science and moral values still
work together, but they simply produce fallacious and ironically ludicrous results. Science has lost the efficacy it had for Galdós' scientist-humanitarian figures.

In our last novel, Corte de cortezas, science and morals separate definitively. Science is willfully destroying the individual. The destruction of Adam's brain becomes the symbol for the destruction of all human individuality by a technological society which uses man for its own ends.

Stylistically Corte de cortezas is much less interesting and innovative than Tiempo de silencio. The story is told in the third person by an omniscient narrator. This narrator focuses his narrative around Adam and supplies the reader with the necessary information for his characterization. The narrator tells us, for example, that Adam is alienated ("Siempre luchó por acercarse algo a alguien, sin lograrlo verdaderamente nunca."\(^\text{16}\) and that he has attempted suicide. There is, however, little actual penetration into Adam's psyche. Sueiro never actually takes us into the consciousness of his character as Martín-Santos does, allowing us to form our own interpretation of personality. He merely provides us with information and establishes the characterization of Adam for us.

On the whole, the narration is objective and external. We are presented with a rather cold, detached view of the destruction of an individual. This objective climate is admirably suited to Sueiro's purpose. The objective tone of the narrative parallels the climate of scientific objectivity which destroys Adam. It is as if the nar-
rator too has become dehumanized by technology to the point where he has no human sympathies for Adam's tragic figure. The transplant of a human brain becomes for the narrator too a mere "corte de corteza," like paring away the rind from a ripe fruit. But the narrator's restraint has still another value. Throughout the novel the narrator alludes to the fact he knows more about Dr. Blanch's evil activities than he is revealing. This continual allusion creates an atmosphere of hidden evil; we never know the worst. This suggestion of unspeakable horror is almost more effective than the symbol of Adam's destruction in establishing the irremediably evil nature of the modern scientific-technological society.

Here again Sueiro's work concentrates on the alienated individual. Adam, whose name symbolically suggests everyman, is the focal point of the entire novel. And Adam, like the characters we have seen in the works of Unamuno and Martín-Santos, is alienated. Sueiro establishes the fact of Adam's alienation by merely giving us information "desde fuera" instead of allowing us to penetrate Adam's consciousness and experience his estrangement "desde dentro" as Martín-Santos does. But the end result is much the same. We see the character alone, separated from society. In Sueiro's work, however, this separation between the individual and the surrounding society becomes even more marked. Adam is not just outside of society. He is actually in conflict with the surrounding society which preys upon him, capriciously seizing the essence of his individuality -- his mind -- and ultimately destroying him.
1. J. Bronowski and Bruce Mazlish, *The Western Intellectual Tradition*, p. 496.

2. Ibid., p. 495.


4. Ibid., p. 162.

5. Felipe Ximénez de Sandoval, *Cadalso (Vida y muerte de un poeta soldado)*, p. XXII.


7. Ibid., p. 223.

8. Ibid., p. 278.

9. Ibid., p. 223.


CONCLUSION

In conclusion let us attempt to briefly summarize our findings. We have seen that the birth of the modern scientific method in the seventeenth century was accompanied by a burst of optimism. The laws of nature and all of her secrets seemed at last accessible to human understanding. Scientists were confident that everything could be understood in terms of matter and motion. Fixed causal laws were seen to stand behind the workings of nature. Scientists were confident that man had only to understand these laws in order to use nature for his own benefit. Reason could unlock the secrets of the universe, and using his powers of reason man could progress, gradually perfecting himself and his society. This faith in progress and human perfectibility becomes one of the seminal concepts of eighteenth-century thought.

This optimism, born of the scientific revolution, is reflected in Cadalso's work which embodies the spirit of eighteenth-century Spain. Cadalso reflects the view that science does indeed hold the keys of progress and that Spain can reap positive benefits of economic and material well being and improve her international image through the study of this new discipline.

The spirit of scientific optimism continues in the nineteenth century as Charles Darwin's discovery of the evolutionary mechanism seems to confirm belief in a mechanistic universal system totally
understandable in terms of cause and effect. In Spanish literature the nineteenth-century spirit of optimism finds in Pérez Galdós its most able exponent. Once again science is seen as contributing to mankind's material and spiritual progress.

By the mid twentieth century two world wars and the proliferation of technology they stimulated began to cast ominous shadows of doubt. Unmitigated optimism regarding science's application was no longer possible. In addition, the twentieth century revolution in physics showed the definitive limits of science, and seemed to question the very foundation of modern science -- the laws of cause and effect. For the first time, scientists themselves began to question the value of science as a discipline capable of discovering ultimate truth.

This crisis of confidence in science is again reflected in contemporary Spanish fiction. Unamuno questions the value of science in transcendental questions. Martín-Santos destroys the myth of the infallible power of reason and science. And finally Daniel Sueiro writes a condemnation of both science and technology and the intolerable society they conspire to create.

The close parallel between the climate of optimism or of pessimism generated by the scientific discoveries we have documented and the literary works of the same time periods is, of course, far from coincidental. The entire "weltanschauung" or world outlook of our times has been perhaps more influenced by science and its discoveries than by any other single factor. Literature of necessity faithfully
conveys the dominant world concept of its time and thus acts as a mirror reflecting the changing world image created by science.

But in addition to functioning as a mirror, merely reflecting scientific developments, literature offers an added dimension for it can give us a feeling for the effect of these changes on the human spirit -- the effect the scientific revolution has had on man's concept of science and morality and on his concept of himself in reference to his surrounding society. Literature faithfully records the effect of these changes explicitly in its themes and implicitly in the style in which its authors choose to express themselves.

The literary works we have examined record a marked change in man's concept of the relationship between science and religion and moral values. For Cadalso, science and religion and morals belonged to two essentially different realms and thus he did not see them as being in conflict. Like Cadalso, Galdós sees no conflict and is able to harmonize the scientific and the religious. He actually endows science with a moral purpose and portrays the scientist as a humanitarian figure who uses the medium of science to help his fellows progress spiritually as well as materially. But when we reach the twentieth century we see the concept of the relationship between these two worlds begin to change. The alteration in the concept of the relationship between science and morals occurs simultaneously with the shift from optimism to pessimism, and seems to be a slightly different manifestation of this change. Concurrently with the twentieth-century tendency towards pessimism regarding science we see a rupture between
the scientific on the one hand and the religious and moral on the other. This separation is first seen in our study in the work of Unamuno who envisions the realm of science and reason destroying the religious and vital. Sueiro too indirectly reflects the dominant trend to see science and morals as components of separate worlds, for although in his novel science and morals are still seen attempting to function in harmony, science leads to fallacious results and no longer has the effectiveness it enjoyed in Galdós' works where it functioned as an aid to morality, disciplining man to see and accept his moral responsibility towards others and providing a medium for social service. The definitive break between science and morals occurs, of course, in our last novel where Sueiro portrays science and the scientist as inherently evil.

While the change from optimism to pessimism can be traced in the history of science itself, a study of the style of our literary works demonstrates that literature can contribute an added dimension to understanding the ramifications of this change. The epistolary and symbolic styles of Cadalso and Galdós respectively reveal that their authors felt the problems raised by the new sciences to be social rather than individual in nature. They therefore chose the literary forms which would provide them with the best means of social criticism and allow them to maintain an objective distance between themselves and their work. Since they did not feel that science had created any problems for the individual as distinguished from the society at large, the social reform they advocated was designed to
cure all ills -- both social and individual.

The twentieth century functions as a turning point. In the present century we see science beginning to effect intimate beliefs and to cause individual anxieties which cannot be cured by social reform. The individual and the social separate. We see this separation beginning in Amor y pedagogía. Avito can no longer find happiness serving society as Galdós' characters frequently did. Society cannot help Avito in reconciling science and religion or answering questions of transcendental value. The result is the alienation characteristic of so many of the characters of contemporary fiction. We pointed out the fact that the emphasis on science and technology, the neglect of the social sciences, and the failure of institutional reforms combined to create this climate of individual alienation. Man was left on his own resources, without the help of guiding social institutions. The important factor for our study, however, is the fact that this shift of emphasis from regarding the changes brought by the advancing sciences as a social problem to regarding it as an individual one can be seen in the style of the literature of the respective time periods. Beginning with Unamuno, the individual rather than the social is given prominence within the narrations and authors begin to develop the monologue and its kindred forms as means of penetrating the individual psyche. In all cases the authors reveal their chief personages as frustrated and fearful, and show that in some way science itself is responsible for their dilemma. The literary distance maintained by Cadalso and Galdós vanishes and the authors either enter directly into
their works, using their characters as mouthpieces for their personal anxieties or symbolically suggesting that their characters represent universal contemporary man, themselves included.

The breakdown of the authors' objectivity combined with their concentration on the alienated individual rather than the social or the individual in harmony with society provides eloquent testimony to the fact that contemporary science is no longer merely upsetting the social order as a whole, but has produced changes in world view that are now intimately affecting individuals, their concept of values, of self and others and their place in society. It is a chronicle that social and physical scientists would do well to study. Perhaps the chronicle to be found in literature would help the social scientists trace a way out of the dilemma posed by the advancing sciences and help the physical scientists re-direct technology to bring its effects into greater harmony with the demands of the human spirit. It is, of course, a two way street. A study of the history of science can enable students of literature to achieve a more sensitive understanding of the way in which science has effected the general "weltanschauung" and the literature which captures its reflection. As Cadden notes in the introduction to a book devoted to the general study of the relationship between science and literature:

Science tends to be ignored by humanists or literary intellectuals, except defensively, as a discipline altogether outside the pale of belles lettres. But the increasingly broad impact of science threatens to make deliberate ignorance indefensible and even
'an act of literary cowardice,' as Aldous Huxley has claimed....

If this dissertation succeeds in increasing its readers' understanding of the impact of science on Spanish literature, its purpose will have been achieved.
John J. Cadden and Patrick Brostowin, editors, Science and Literature: A Reader, p. V.
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