

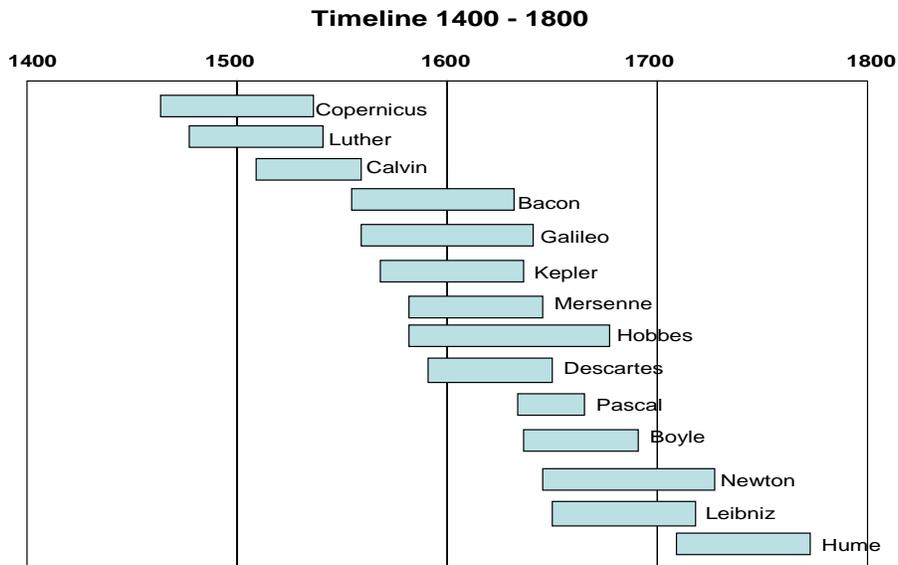
## Calvin's Role in the History of Science

Paul Arveson, May 2009  
for Calvin's 500th birthday

The undisputed historical fact is that modern science arose somewhat before and during the Reformation in Europe, and nowhere else before this. The question historians want to know is *why* then and there? What was unique about this milieu, and did it have anything to do with Reformed theology, or Calvin in particular?

An increasing number of historians, philosophers, theologians and sociologists have proposed various accounts of the rise of science. Many have had an axe to grind, one way or the other, on this question. Of course the most startling and outrageous of them were John William Draper, who wrote a *History of the Conflict Between Religion and Science* in 1874, and Andrew Dickson White, founding president of Cornell University, who wrote *A History of the Warfare of Science with Theology in Christendom* in 1896. The titles tell the story: these authors characterized the whole relationship between science and religion as a long and continuing war. (Carl Sagan taught at Cornell; it might be appropriate to say that Cornell has had a long history of warfare with theology.)

Calvin, Luther, and Copernicus were contemporaries, as shown in the following timeline of some famous theologians, scientists and philosophers:



It is true that Luther spoke of Copernicus in an off-the-cuff disparaging remark in a *Table Talk*, but never in his scholarly works. However, more recent historians recognize that Draper and White were simply wrong in their general conclusions; it is factually incorrect to characterize the history of science and Christianity as a warfare in any period. There are now many accounts that refute Draper and White, and they have reconstructed more accurate and nuanced histories of science. I'll give you one example:

Bertrand Russell, in his *History of Western Philosophy*, quoted Luther's well-known quip about Copernicus as a fool that would upset astronomy, and then added:

"Calvin, similarly, demolished Copernicus with the text: "The world also is established, that it cannot be moved", Psalm 93:1, and exclaimed "Who will venture to place the authority of Copernicus above that of the Holy Spirit?" [p. 528]

This quote is simply not to be found in Calvin's commentary on the Psalm. More recent scholars have never found such a statement in any of Calvin's writings. Rosen, in *Copernicus and His Successors* (1995), traces the origin of this fabrication back through A.D. White and a sequence of other authors. However, a citation of Calvin is never mentioned. They conclude:

"Surely this ample body of evidence authorizes us to conclude, despite Professor Shields, Canon Farrar, President White, Miss Stimson, Dean Inge, Lord Russell, Father Conway, and Dr. Will Durant, that Calvin never demolished, condemned, rejected, opposed, or stigmatized as an utter reprobate the quiet thinker who founded modern astronomy.

What, then, may we ask at the end of our inquiry, was Calvin's attitude toward Copernicus? Never having heard of him, Calvin had no attitude toward Copernicus."

[*Copernicus and his Successors*, E. Rosen, ed. E. Hilfstein (1995) A similar conclusion was reached about 40 years earlier by R. Hooykaas.]

On the other extreme there have also been some recent writers who, noticing the historical fact of the unique emergence of science and its practical benefits in the Christian West, have made this into an apologetic for the faith, as evidence for the truth of Christianity.

Probably the first one of these, ironically, was Alfred North Whitehead, in *Science and the Modern World*, 1925, where he contrasted Western attitudes with those of Eastern civilizations:

"In Asia, the conceptions of God were of a being who was either too arbitrary or too impersonal for such ideas to have much effect on instinctive habits of mind. Any definite occurrence might be due to the fiat of an irrational despot, or might issue from some impersonal, inscrutable origin of things. There was not the same confidence as in the intelligible rationality of a personal being. I am not arguing that the European trust in the scrutability of nature was logically justified even by its own theology. My only point is to understand how it arose. My explanation is that the faith in the possibility of science, generated antecedently to the development of modern scientific theory, is an unconscious derivative of medieval theology."

Even Joseph Needham, the Marxist scholar of Chinese culture, concluded that China failed to develop science because it "lacked the idea of creation". [*The Great Titration: Science and Society in East and West* (London: Allen & Unwin, 1969) p. 36.]

Stanley Jaki, a Hungarian Benedictine priest, prolific author and winner of the Templeton Prize (who just died on April 7, 2009), wrote about

"...the fundamental paradigm of science: its invariable stillbirths in all ancient cultures and its only viable birth in a Europe which Christian faith in the Creator had helped to form." [*The Road of Science and the Ways to God*, 1978].

Father Enrico Cantore, another professor at Fordham University with Jaki, wrote a paper called "The Christic Origination of Science" (1985) [*J. Am. Sci. Affil.* 37: 211ff (Dec. 1985)], outlining in detail the Christian presuppositions that underlie modern science, such as intelligibility of the natural world, realism, elimination of the fear of nature, and other ideas that scientists now take for granted.

Even more recently, Rodney Stark wrote in 2003:

"[T]heological assumptions unique to Christianity explain why science was born only in Christian Europe. Contrary to the received wisdom, religion and science not only were compatible; they were inseparable.... *Christian theology was essential for the rise of science.*" [*For the Glory of God*, 2003].

We could make the case for a pro-Christian historiography even stronger by noting that Greek philosophy had had *two chances* to develop science, first in their Golden Age up to about 300 BC, and second after the reintroduction of Greek philosophy into Europe by the Muslim Moors in the 13th century. Although Aristotle in particular introduced some important foundational concepts in his *Physics*, the pagan Greeks failed both times to turn natural philosophy into a practical, experimental, ongoing enterprise. It took something else to do that. Was this Christian theology? And more to the point here, was it *Reformed* Christian theology?

If one were to try to identify a Calvinist theological doctrine that triggered the scientific revolution, it would not be hard to do. There are many plausible possibilities; I'll offer ten of them, many of which were suggested by Reier Hooykaas of the University of Utrecht in his excellent (1972) book *Religion and the Rise of Modern Science*:

1. The reality of the subject matter of nature - Unlike Eastern philosophies, many of which consider matter to be an illusion, and thus unimportant and unethical to study, Christian theology insists on the reality of the world as God's good creation, and not only that, but also that this reality is intelligible and substantially knowable to mankind. Realism is a point that was insisted on by Copernicus in his new view of the solar system. (This is not to go so far as the Thomists and say that we can construct a natural theology through reason or observation alone, however).

2. Love of nature - the early Protestant scientists like Coiter, Clusius and Palissy recognized nature as the work of God's hands, and often expressed their pleasure in

investigating the beauty and intricate structure of natural objects in anatomy, zoology and botany. [Hooykaas p.105]

3. The glory of God - The central theme of Reformed theology was the glory of God. Kepler wrote in 1598 that the astronomers, as priests of God to the book of nature, ought to keep in their minds not the glory of their own intellect, but the glory of God above everything else. [Hooykaas p.105]

4. Our pious duty - Calvin suggested that those who neglected the study of nature were as guilty as those who forgot the Creator. Again and again he argued that the direct study of nature penetrates deeper into the knowledge of God than mere contemplation. This duty is not a legal burden but something to be enjoyed as a task of love and gratitude.

According to Calvin, "those who have the leisure and the ability" ought not to neglect studies like astronomy. [Hooykaas p.106] We see this attitude expressed in the writings of early scientists like Thomas Digges and Johannes Kepler, who considered their research in the light of the parable of the talents [Hooykaas p.106].

5. Providence - The world is not a chaos, but a world of order. Yet it is not a world of necessity, as though it was some kind of autonomous machine. It is a world under the will of God, that is, providence. Thus Calvin's voluntaristic view of natural causes differed from Thomism, with its notion of natural law that implied a kind of determinism. (In Calvin's *Institutes*, in the chapter on Providence he says that God's fatherly hand is in all things that happen; the order comes from God, but the miracles, the deviations from this order, also come from God. So there is no theological distinction between "supernatural" and natural; God's providence operates equally and fully in both, either directly, or through second causes in the world.) [Hooykaas p. 107]

6. The priesthood of all believers - This emphasis of Calvinism empowered the laity and showed the sanctity of all occupations. This principle implied the right, and even duty for everyone to study the Scriptures for themselves, without any mediating interpreter, and also to study nature, without regard to the ancient authorities of natural philosophy. The Huguenot Bernard Pallisy, criticized for his lack of knowledge of Greek and Latin, replied that "I have had no other book but heaven and earth, which is known to everybody, and it has been given to *every man* to know and to read this beautiful book." [Hooykaas p.109, ref. 37]

7. Liberty of conscience and tolerance of a diversity of thought - Protestants had been trained to the religious principle that each man accepts the responsibility for finding the truth for himself, without a human authority to mediate between him and God. In an environment of political and religious sectarianism, Hooykaas suggested that "scientific sectarianism could also easily develop and a large measure of scientific freedom was the inevitable consequence." [Hooykaas p.109]

8. The doctrine of election - Max Weber and Robert Merton suggested that Calvin's doctrine of election inspired the ascetic Protestant work ethic that led to economic growth and modern capitalism.

9. Belief that manipulation of nature can be beneficial - Francis Bacon was the champion of this cause in contradiction to the attitude of the Greeks and the Scholastics, that it was undignified or unspiritual to get one's hands dirty in doing experimental and practical work, in order to devise ways of relieving the burdens of life. For instance, the claim that churches taught that the curses of the Fall, such as pain in childbirth, were meant to be

accepted and not mitigated with anesthetics, was another myth perpetrated by Draper and White. [Numbers, myth #14]

10. The two books of God - Nature is the general revelation of God, alongside Scripture, the special revelation. Both of these books ought to be read and studied for our benefit.

Unfortunately, for all of these plausible ways of linking theology to science, these are *post facto* speculations. For proof we will need more direct evidence, such as arguments made by the Reformers directly. For some of the views listed above, we can find statements in Calvin's *Institutes* and the *Commentaries* that provide this evidence. But we can also find many passages where he alluded to the received view of cosmology, *i.e.*, Aristotle's view.

Calvin's burden was not to formulate a natural philosophy, but a theology. In so doing he needed on occasion to sometimes use and sometimes refute the Greeks and other views known to him. But his main message was theological: that we must have an attitude of humble reverence toward both God and His works. He did not disparage study of nature, quite the contrary, as when he says in the *Institutes*:

" It is unnecessary to dwell at length on the end that should be aimed at in considering the works of God. The subject has been in a great measure explained elsewhere, and in so far as required by our present work, may now be disposed of in a few words. Undoubtedly were one to attempt to speak in due terms of the inestimable wisdom, power, justice, and goodness of God, in the formation of the world, no grace or splendor of diction could equal the greatness of the subject. Still there can be no doubt that the Lord would have us constantly occupied with such holy meditation, in order that, while we contemplate the immense treasures of wisdom and goodness exhibited in the creatures as in so many mirrors, we may not only run our eye over them with a hasty, and, as it were, evanescent glance, but dwell long upon them, seriously and faithfully turn them in our minds, and every now and then bring them to recollection. But as the present work is of a didactic nature, we cannot fittingly enter on topics which require lengthened discourse."

[*Institutes*, Book I, ch. XIV, S. 21]

We need to remember that in the 16th century there was no such enterprise as what we call "science", and experimental studies in alchemy, physics and astronomy were referred to as natural philosophy. They were studies carried out as hobbies or pastimes of people who had practical day jobs; Calvin's contemporary Copernicus, for example, was a canon, or what we would call a regional government administrator in northern Poland. (Although he took holy orders in the church, it isn't quite correct to call him a priest, both because he didn't take the formal step, and also because his household maid lived with him). And as we noted earlier, apparently Calvin never heard of him. On the other hand, Copernicus had certainly heard of the Reformers. In Copernicus' later years he continued as an administrator, in his spare time refining his calculations for his book on the solar system. Meanwhile the Reformation grew rapidly in Warmia, and although the Polish kingdom remained Catholic, writings of the Reformers were widely read. Copernicus

was open to the new ideas, but not to the breakup of the church. He apparently preferred Calvin's metaphorical view of the Eucharist "*Hoc est corpus meo*" over Luther's literal view.

So if indeed there was an influence on science from Calvin, it was indirect and mediated through secondary sources, especially advocates of the new attitude toward natural philosophy who came a few generations after Calvin, such as Kepler, Galileo, and Francis Bacon.

### **Calvin's View of Scripture Interpretation**

Calvin wrote commentaries on every book in the Bible except Revelation. Right at the beginning, in commenting on Genesis 1:6-7 regarding the "waters above the firmament" he set forth an *accommodationist* view of interpretation:

“Moses describes the special use of this expanse, to divide the waters from the waters from which word arises a great difficulty. For it appears opposed to common sense, and quite incredible, that there should be waters above the heaven. Hence some resort to allegory, and philosophize concerning angels; but quite beside the purpose. For, to my mind, this is a certain principle, that nothing is here treated of but the visible form of the world. He who would learn astronomy, and other recondite arts, let him go elsewhere. Here the Spirit of God would teach all men without exception; and therefore what Gregory declares falsely and in vain respecting statues and pictures is truly applicable to the history of the creation, namely, that it is the book of the unlearned.”

Thus, Calvin interpreted the "waters above the firmament" simply as the clouds.

In commenting on some Scripture passages in the Psalms, Calvin suggested that it would be ridiculous to take them literally; God revealed things in a way that accommodated everyday speech of uneducated people. After all, the Gospel is simple enough that its essential truths must be able to reach anyone, not just scholars. That is the error of much of the rationalistic proofs like those of Aquinas -- they only have weight with other scholars, they cannot possibly be of value in evangelism to the peasants or the uneducated masses of people. Jesus, on the other hand, spoke to these common people and they followed him. Calvin was sympathetic with this idea of accommodation, as for example in his commentary on Genesis 1:16:

"Moses wrote in a popular style things which without instruction, all ordinary persons, endued with common sense, are able to understand; but astronomers investigate with great labor whatever the sagacity of the human mind can comprehend. Nevertheless, this study is not to be reprobated, nor this science to be condemned, because some frantic persons are wont boldly to reject whatever is unknown to them. For astronomy is not only pleasant, but also very useful to be known: it cannot be denied that this art unfolds the admirable wisdom of God. Wherefore, as ingenious men are to be honored who have expended useful labor

on this subject, so they who have leisure and capacity ought not to neglect this kind of exercise. Nor did Moses truly wish to withdraw us from this pursuit in omitting such things as are peculiar to the art; but because he was ordained a teacher as well of the unlearned and rude as of the learned, he could not otherwise fulfill his office than by descending to this grosser method of instruction. Had he spoken of things generally unknown, the uneducated might have pleaded in excuse that such subjects were beyond their capacity. Lastly since the Spirit of God here opens a common school for all, it is not surprising that he should chiefly choose those subjects which would be intelligible to all. If the astronomer inquires respecting the actual dimensions of the stars, he will find the moon to be less than Saturn; but this is something abstruse, for to the sight it appears differently. Moses, therefore, rather adapts his discourse to common usage."  
 [Commentary on Genesis 1:16]

Some writers are more sensitive to the range of literary usage than others. Hooykaas makes the insightful comment that calling a metaphor an error or a lie, as some Reformed scholars did, shows a lack of literary imagination; it is a rather childish literalism that fails to recognize other literary forms than straight journalistic narrative. But the Hebrew Bible is full of all kinds of different genres and styles of literature. Recognizing this, Calvin says that Moses is not purporting to equate "propositional truth" with a journalistic or scientific account. This accommodation hermeneutic was suggested by Augustine in relation to the Incarnation, but Calvin recognized the need for it, more than Luther, more than the Catholics, and more than many other commentators. I think a little more of this literary sensitivity would have saved us from a lot of unnecessary conflicts:

Absolute fact <----- Poetic metaphor -----> Absolute error

Judgments of both fact and error in the text imply that the reader has absolute knowledge and certainty about the question at hand. But that is a false assumption; it violates the basic Calvinistic doctrine of the limitations of knowledge. B. B. Warfield identifies three reasons for these limitations: 1) humans are finite creatures; 2) we are to some extent immature and have limited experience; 3) the noetic effects of sin. So even if we interpret the text literally, we don't know the facts; we cannot therefore render absolute judgments one way or the other. Calvin, as a layman in astronomy and other sciences, had no interest in confronting experts in fields he knew little about.

This attitude of theologians toward the knowledge of nature was also emphasized by Augustine in his book *The Literal Meaning of Genesis* [*De Genesi Ad Litteram*, 401 AD]:

"Usually, even a non-Christian knows something about the earth, the heavens, and the other elements of this world, about the motion and orbit of the stars and even their size and relative positions, about the predictable eclipses of the sun and moon, the cycles of the years and the seasons, about the kinds of animals, shrubs, stones, and so forth, and this knowledge he holds to as being certain from reason and experience. Now, it is a disgraceful and dangerous thing for an infidel to hear

a Christian, presumably giving the meaning of Holy Scripture, talking nonsense on these topics; and we should take all means to prevent such an embarrassing situation, in which people show up vast ignorance in a Christian and laugh it to scorn. The shame is not so much that an ignorant individual is derided, but that people outside the household of faith think our sacred writers held such opinions, and, to the great loss of those for whose salvation we toil, the writers of our Scripture are criticized and rejected as unlearned men. If they find a Christian mistaken in a field in which they themselves know well and hear him maintaining his foolish opinions about our books, how are they going to believe those books in matters concerning the resurrection of the dead, the hope of eternal life, and the kingdom of heaven, when they think their pages are full of falsehoods on facts which they themselves have learnt from experience and the light of reason? Reckless and incompetent expounders of Holy Scripture bring untold trouble and sorrow on their wiser brethren when they are caught in one of their mischievous false opinions and are taken to task by those who are not bound by the authority of our sacred books. For then, to defend their utterly foolish and obviously untrue statements, they will try to call upon Holy Scripture for proof and even recite from memory many passages which they think support their position, although "they understand neither what they say nor the things about which they make assertion."

This humble attitude toward nature and expert knowledge outside of theology is one of the things that shows Augustine's true greatness: his willingness to admit his limitations, defer to others who are more expert than he, and even be willing to change his own views to accommodate the established facts. Calvin took Augustine's example in regard to the details of astronomy. It is sad that we have lost such an attitude today in the writings of the American creationists. They are quite willing to attack, abuse, suppress or twist the data to fit their preconceived, childishly literal interpretation of Scripture.

### **Francis Bacon**

The English philosopher Francis Bacon, Lord Verulam, was the one of the first to make Reformed theology relevant in the observatory and the laboratory. Bacon's works championed the overturning of the Scholastic, Aristotelian order, along with the Catholic theology that embraced it too closely. But even then, there was no warfare. In fact Bacon did an exemplary job of integrating his faith and his science, affirming both.

I have found books that claim that Bacon was a Puritan like his devout mother, Ann, [Bowen], books that claim he was a devout Anglican all his life [Coquillet], and a book that claimed he became a Catholic later in life [Matthews]. So I had to take recourse in what Bacon had to say for himself. At some point he wrote his own confession of faith, so I have his own words for it, without needing to rely on labels attached by others. He was clearly not a Catholic; and in my humble judgment the confession is not inconsistent with Calvinist theology.

Bacon did not directly contribute to scientific knowledge, but he served as its visionary, its voice crying in the wilderness. Bacon's Elizabethan literary style was similar to that

of Shakespeare and the King James Bible, which was published in 1611. This was a time when English was at a peak in terms of vocabulary, and Bacon made good use of it, along with an ample dose of wit.

It will be worthwhile to let Francis Bacon speak for himself. He wrote a number of *Aphorisms* in the *New Organon* of 1620. (The aphorisms were shorter and more pithy even than his famous *Essays*; this was a common literary form of the time):

"Neither is it to be forgotten that in every age Natural Philosophy [science] has had a troublesome adversary and hard to deal with; namely, superstition, and the blind and immoderate zeal of religion. For we see among the Greeks that those who first proposed to men's then uninitiated ears the natural causes for thunder and storms, were thereupon found guilty of impiety. Nor was much more forbearance shown by some of the ancient fathers of the Christian church to those who on most convincing grounds (such as no one in his senses would now think of contradicting) maintained that the earth was round, and of consequence asserted the existence of the antipodes.

"Moreover as things now are, to discourse of nature is made harder and more perilous by the summaries and systems of the Schoolmen [Scholastics]; who, having reduced theology into regular order as well as they were able, and fashioned it into the shape of an art [form], ended in incorporating the contentious and thorny philosophy of Aristotle, more than was fit, with the body of religion.

"To the same result, though in a different way, tend the speculations of those who have taken [it] upon them[selves] to deduce the truth of the Christian religion from the principles of philosophers, and to confirm it by their authority; pompously solemnising this union of the sense[s] and faith as a lawful marriage, and entertaining men's minds with a pleasing variety of matter, but all the while disparaging things divine by mingling them with things human. Now in such mixtures of theology with philosophy only the received [Greek] doctrines of philosophy are included; while new ones, albeit changes for the better, are all but expelled and exterminated.

"Lastly, you will find that by the simpleness of certain divines, access to any philosophy, however pure, is well nigh closed.

"Some are weakly afraid lest a deeper search into nature should transgress the permitted limits of sober-mindedness; wrongfully wresting and transferring what is said in holy writ against those who pry into sacred mysteries, to the hidden things of nature, which are barred by no prohibition.

"Others with more subtlety surmise and reflect that if second causes are unknown everything can more readily be referred to the divine hand and rod; a point in which they think religion to be greatly concerned; which is in fact nothing else but to seek to gratify God with a lie.

"Others fear from past example that movements and changes in philosophy will end in assaults on religion. And others again appear apprehensive that in the investigation of nature something may be found to subvert or at least shake the authority of religion, especially with the unlearned.

"But these two last fears seem to me to savour utterly of carnal wisdom; as if men in the recesses and secret thoughts of their hearts doubted and distrusted the strength of religion and the empire of faith over the sense[s], and therefore feared that the investigation of truth in nature might be dangerous to them.

"But if the matter be truly considered, natural philosophy is after the word of God at once the surest medicine against superstition, and the most approved nourishment for faith, and therefore she is rightly given to religion as her most faithful handmaid, since the one displays the will of God, the other His power. For He did not err who said "Ye err in that ye know not the Scriptures and the power of God" [Mark 12:24], thus coupling and blending in an indissoluble bond information concerning His will and meditation concerning his power.

"Meanwhile it is not surprising if the growth of Natural Philosophy is checked, when religion, the thing which has most power over men's minds, has by the simpleness and incautious zeal of certain persons been drawn to take part against her."

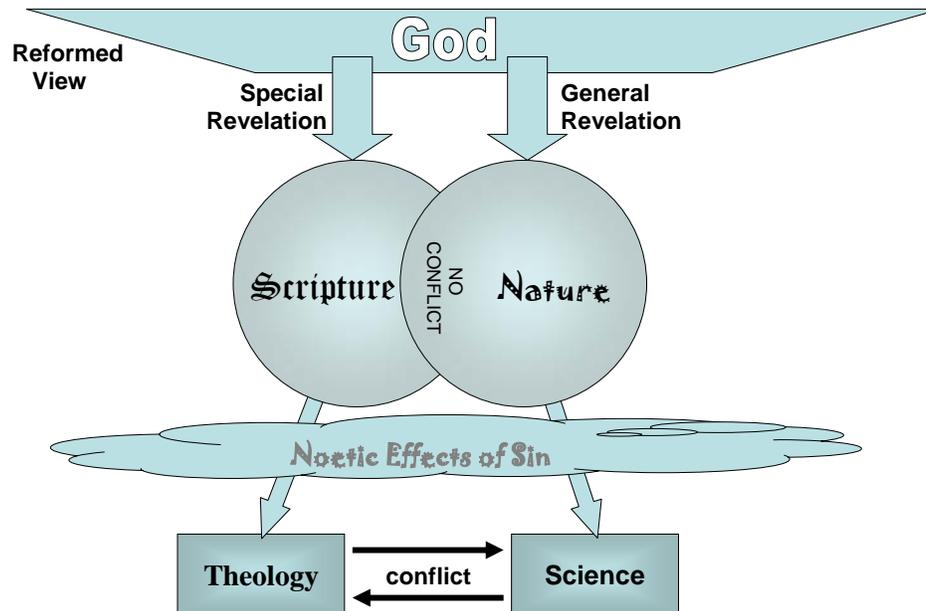
Bacon wrote this defense of empirical science against both the futile speculations of the Scholastic (Aristotelian) philosophers and the 'blind and immoderate zeal of religion' at the beginning of the modern scientific age which he himself helped to usher in. It provides a brilliant example of the integrated view of science and Christian faith of a true "Renaissance man" before the problems of modernity arose in the Enlightenment.

Earlier I mentioned the concept of the "two books of God" -- the Bible, as the special revelation, and nature, as the general revelation. This formulation was repeated also by Galileo in his defense of his Copernican views: "The Bible tells us how to go to heaven, not how the heavens go." Galileo's books were suppressed during the counter-Reformation, and he was placed under house arrest in Florence in 1633, but recent scholars have concluded that he was certainly not imprisoned or tortured [Hummel, Numbers].

This concept of the two books of God can be illustrated, with variations to show the ways in which these two books have been emphasized in history.

If Calvin could have contributed to this picture, I think he would have added an important feature that was neglected by Aristotle, Plato, the Thomistic rationalists, Catholic literalists, and even perhaps Luther: the "noetic effects of sin" -- the effects of sin that act like clouds that keep us from knowing God's Word or ourselves or nature with clarity and certainty. The impact of this cloud barrier is to do away with "positivistic" approaches to either Scripture or nature, which insist that they are absolutely right and true, thus

creating a direct conflict with those who believe otherwise. As the Scriptures themselves say, "If any man says he knows something, he does not know as he ought to know." (I Cor. 8:2). Christians have a self-awareness of their epistemological limitations. With this more appropriate and humble attitude, all conflicts are blunted.



In this picture, we see the "two books of God" as the Special Revelation (Scripture) and the General Revelation (nature). The two books come from the same source, so ultimately there can be no conflict between them. This implies the principle of the *unity of truth*, which was affirmed by Augustine. From Scripture, humans derive systems of theology, and from nature they derive scientific theories. If this were the end of the story, we would have a *positive* view of the world, and we would expect no conflicts between different parts of the truth. However, humans are finite and fallen creatures, so we experience hermeneutical problems and epistemological problems. These give rise to a breakdown in the unity of truth and to various kinds of conflicts between the human systems of theology and science. But "in the beginning it was not so."

### Conclusion

History isn't what it used to be. Based on the more recent scholarship, I think it is fair to conclude that Calvin did have a *real* influence on the progress of science, but that influence was *indirect*. It came through his contributions to Reformation thought, mediated by printed books, which eventually pervaded all aspects of religion and philosophy, including natural philosophy or what we now call science.

But there were many other conditions that facilitated both the Reformation and the rise of science. The invention of printing was one key step. Not only the Bible, in vernacular

languages, but also theological books and scientific books like Copernicus' *De Revolutionibus Orbium Coelestium* ("On the Revolutions of the Heavenly Spheres") were also published and widely distributed beginning in the late 15th century.

In addition to theological and philosophical innovations, historians have identified many other social and economic conditions that also played a role in the rise of modern science. Here are some of them:

1. Establishment of the university system by the Catholic Church;
2. Rise of the burgher class, trades and guilds;
3. Discovery of the New World;
4. Breakdown of the hegemony of kings and especially the Pope;
5. Rich material resources coming from mines and from around the world, stimulating economic growth (e.g. tulip mania of 1637). (I should mention in this regard the new emphasis on materialist historiography led by Jared Diamond's *Guns, Germs and Steel*);
6. Evolution of military engineering, basically the need for more sophisticated weapons; a form of "survival of the fittest" (likewise a part of Diamond's thesis).

Of course there were also many hindrances to any kind of intellectual progress during the early 17th century, particularly the Thirty Years' War (1618-1648) and the plagues that periodically swept through the continent. Most of the individuals we mentioned as leaders both in theology and philosophy were obliged to fight or flee for their lives at various times.

The end product of this history is what we call modern science, with its established theories, methods of mathematics, controlled experiments, independent verification, sampling statistics, specialized instrumentation and the rest. How it all got here is a complex story, and therefore subject to the bias of the historian. I can imagine this cluster of methods and theories as a kind of stew that was put together by many contributors. Theological, technological, social and economic changes worked together, in the same direction, to drive progress in scientific knowledge. The interactions between them are nearly impossible to untangle, so the consensus of modern historians is that there was a *confluence* of forces at work during the Reformation. But Calvin's contribution to theological change was an important one of those forces, the salt in the stew.

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