This paper advocates a reconceptualization of the history of science and religion. It is an approach to the subject that would aid research by historians of science as well as their message to others, both academic and non-academic. The approach is perfectly illustrated by the life and ideas of William Whewell and Galileo.

**Keywords:** religion; science; Whewell; Galileo

The relation between science and religion remains a contentious issue, in various ways. As with other areas of history, accurate histories of religion and science help to clarify our understanding of the present, in this case of current relations between science and religion. For the past few decades, historians of science have written excellently and voluminously on the subject. They have legitimately attacked the view that religion and science have invariably, or at least usually, conflicted with each other; in doing so, historians have often put the words *science* and *religion* in inverted commas, signalling a lack of specific and universal meanings for those words. In that ongoing context, this paper offers an even more extensive reconceptualization of the subject. It recommends a method of diagramming ideas, in the absence of the words *religion* and *science*.

The paper has a twofold thesis. First, avoiding the words *science* and *religion* allows—indeed, demands—a more comprehensive and accurate presentation of past ideas. Second, diagramming those ideas is helpful because it forces one to identify precisely the conceptual connections between them. Although they require verbal explanations, such diagrams nevertheless present an instant view of networks of ideas.

But first let us consider William Whewell. Some know much about Whewell; most do not. This paper thus begins with an introduction to the biblically immersed Whewell before discussing the historian Whewell’s account of the ‘Galileo affair’. Both aspects of Whewell, and both Whewell and Galileo, are relevant to the paper’s main theme of reconceptualizing the history of science and religion. The paper then describes and defends that reconceptualization, arguing its significance both for historians’ own understanding of the past and for their communication with others.

Raised in Lancaster, Whewell (1794–1866) entered Cambridge University in 1812, graduating in 1816 as Second Wrangler. Succeeding the next year in the competitive

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fellowship examination at Trinity College, he remained there for the rest of his life. Cambridge was one of England’s early-century centres of evangelical and conservative Christianity, a comfortable context for Whewell. He served as Master of Trinity during his final quarter century. Along the way, he was also Professor of Mineralogy at Cambridge and later Professor of Moral Philosophy. He coined the word *scientist*. His writings and administrative duties helped to shape Cambridge studies of mathematical physics, the natural sciences and moral philosophy. He took Holy Orders in 1826 and delivered sermons in Cambridge from the mid 1820s into the 1860s. He published the most popular of the eight Bridgewater Treatises on natural theology in 1833 and is best known for his volumes on the history and philosophy of science published in 1837 and 1840, respectively. He also wrote significantly on architectural history and political economy. His tidal research earned him a medal from the Royal Society in 1838. Given the obvious significance for this paper of Whewell’s views of God and the Bible, the next several paragraphs explore those aspects of his thought.

In May 1811, five days short of his 17th birthday, Whewell wrote a letter to his younger brother in Lancaster from nearby Deepthwaite. After expressing concern for his eight-year-old brother’s health, William provided considerable educational advice. John had ‘uncommon abilities’, William wrote, but in addition to writing, he needed to read. William recommended ‘Mrs. Chapone’s “Letters to a Young Lady”’, as well as the study of history and natural philosophy. Given John’s ‘propensity for poetry’, he should also read the English poets, as soon as he was capable of understanding them. John currently was writing verse on a ‘subject’ that was ‘generally of a religious nature’. Although William wrote that he himself had a ‘regard for religion’, he ‘dare[d] not yet engage it’. He thought that John should also postpone that topic. ‘The subject is so awful [that is, full of awe] that before the mind is ripened it seems to me fitter for contemplation than for description.’ It was a letter to one boy of ‘uncommon abilities’ from another similarly endowed. Perhaps most revealing was William’s conclusion that ‘religion’ was an awesome and difficult subject.2

One source of that conclusion by William was undoubtedly Hester Chapone’s *Letters on the improvement of the mind: addressed to a lady*. Mrs Chapone first published her 10 letters to her niece in 1773, and the book saw several editions, including one in 1810. ‘The great laws of morality are indeed written in our hearts,’ Mrs Chapone wrote, ‘and may be discovered by reason; but our reason is of slow growth, very unequally dispersed to different persons, liable to error, and confined within very narrow limits in all.’ Even if her niece were intelligent enough, she was still too young to comprehend Christianity ‘on rational grounds’. Most people should rely on the straightforward parts of scripture for such truths, although realizing that maturity and sufficient intellect could eventually establish those truths as inherent, necessary truths. Overall, the stakes were high, for her niece was necessarily on a path leading either to God’s eternal love or to ‘eternal death’.3

Although it would be fanciful to conclude that Mrs Chapone determined the course of Whewell’s thinking, her early letters did strikingly resemble some of his later ideas: the reliability of scripture, the eternal gravity of the enterprise for all, and—most interestingly—the existence of innate truths eventually discoverable through reason by the few.

Elizabeth’s illness began in 1819. She was the eldest of Whewell’s three sisters, who, along with their aunt, formed his immediate family in Lancaster. Whewell’s three brothers (including John), mother and father had already died. Elizabeth was his closest family correspondent. Even though addressed merely to ‘Miss Whewell’ and beginning
‘My Dear Sister’, his letters were clearly for her. Requiring at least two dreadful operations (without anaesthesia) and their painful aftermaths, Elizabeth’s illness pervaded family correspondence.

Whewell’s letters home at this time disclose much. Replying to his aunt’s unexpectedly unfavourable account of Elizabeth’s health at one point, he wrote to his aunt that ‘the goodness of God almighty sometimes opens upon us when we least expect it. He can make the dry bones live and much more can he make the charges of pain and sickness end in health and comfort.’ Indeed, he told his aunt, he regarded the prophecies of Isaiah and Ezekiel ‘as the most sublime parts of the bible’. Especially ‘striking’—and obviously relevant to Elizabeth’s condition—was Ezekiel’s account of God’s resurrecting power in clothing the dry bones in sinew and flesh and bringing them to life. In February 1820, William wrote to Elizabeth that God guided human affairs, even in matters of despair:

> It is only a belief and a feeling that all sorrows come from God Almighty which can enable us to bear them with tranquility. Very often indeed the weight and burden of pain and affliction make us forget that we are in the hands of Him of whom we may be confident that whatever he dispenses to us is for our good. That severe and inscrutable as his ways appear, it is only our short sightedness and ignorance that make them seem so.

Writing to Elizabeth in the following November, he commended her for letting her present difficulties focus her attention on the life beyond this one, invoking the biblical ‘day spring from on high’—that is, the dawn of resurrection following the darkness of death. Elizabeth died seven months later.

This staunch Christianity of Whewell’s persisted to the end, as can be seen in his many sermons—relevant to individuals, the college, the university and the nation. In 1828 he approvingly quoted Francis Bacon’s admonition to ‘peruse’ together God’s scripture and God’s works, concluding ‘that all our greatest lights and worthies have been the most peculiarly pious and religious men’—including the ‘sincere Christians’ (all Trinity men) Bacon, John Ray and Isaac Newton. In 1835 he preached that ancient Rome and modern Britain were alike God’s instruments for diffusing Christianity. ‘Can we doubt that God uses the institutions of men for the furtherance of his own secret counsels?’ God’s intentions underlay modern man’s ‘command... over the elements’ and ability to travel the world—as well as ‘the power that civilized nations now possess in comparison of those that are barbarous’. Three years later in the Trinity chapel, he preached that a liberal education like that at Cambridge certainly required the classical history of Greece and Rome and ‘the science of the modern world’, but it must also ‘connect each man’s Present with his eternal Future’. That is, ‘no education can be liberal which is not also religious’, something encouraged by the daily prayer of ‘members of a Christian family like this’.

On 3 February 1856—62 years after his birth, and a month and a half after the death of his wife—Whewell delivered the most personal of the sermons cited here. Without disclosing details of man’s eternal life, God’s revelation was assurance that it awaited us. ‘We wait for the second coming of Him who has been with us already.’ Just as He will then be transformed ‘from the Son of Man to the Son of God’, we also shall change, though at a lower level:

> We do not know how our outer man may be transformed; but this we know, that our inward [sic] man must be transformed; and must be transformed to a nearer likeness...
with Him than it at first had. We do not know what may become of our bodies—what new body God may give us: now, being unclothed, we shall be clothed again or clothed upon; but we know that our souls must become pure, in order to subsist there. With whatever colours the atmosphere of heaven may glow, we know that it is an atmosphere where impurity cannot breathe.\textsuperscript{10}

Hence, to meet the goal for eternal life, Whewell continued, man must ‘purifieth [sic] himself \textit{in this life}'. That is, he must extinguish ‘that smouldering fire in man’s bosom which the Devil is always ready to stir into a flame’. Failure to so purify meant ‘eternal death’. God’s partial revelation of eternity received support from the more mundane. ‘Perpetual progress in the lower sphere’ implied something similar in the upper. God would not allow the one and deny the other. The observable design, purpose and wisdom in this world implied their existence in a higher one. ‘Even our natural reason—our contemplation of the general plan of the universe—, may assure us that such flowers must have a corresponding fruit . . .’.\textsuperscript{11}

Crucially, for those like himself, Whewell concluded, the time for such necessary perfection ‘is short indeed’. However, ‘even for the youngest of you, the time is short for you to perform this task of your purification—of your preparation for the eternal world.’\textsuperscript{12}

Whewell’s youthful correspondence and decades of sermons confirm the lifetime Christianity of the man who invented the word \textit{scientist} and who was himself a scientist of importance. And he was hardly alone in his conservative Christianity at Cambridge. For example, three similarly minded men who overlapped at Cambridge with Whewell were Isaac Milner, Joshua King and George Gabriel Stokes; these three held Cambridge’s Lucasian professorship of mathematics for eight of the ten and a half decades from 1798 to 1903.\textsuperscript{13} For Whewell, the Christian God pervaded not only his and his family’s lives but also his developing ideas, the natural world, the character of his college and university, and the fate of his nation. Whewell’s God was both an object of human knowledge and an active agent in human affairs.

Similar in important ways is the perpetual example of undoubtedly the most famous religious scientist, Galileo, obviously of interest to Whewell the historian. Whewell concluded that Copernicus and Kepler each commenced an ‘epoch’ in the history of astronomy and that Galileo was the main figure in the Copernican ‘sequel’. In that role, Galileo ‘confirmed by Facts’ heliocentrism. Moons circling Jupiter provided ‘an analogy all but irresistible’ in Copernicus’s favor. Venus’s phases solved ‘a formidable objection’ to Copernicus’s Sun-centred Universe. For whatever reason, Whewell omitted Tycho Brahe’s Earth-centred system in his brief discussion.\textsuperscript{14}

Whewell provided a nuanced and somewhat sympathetic account of what he regarded as the Catholic Church’s mistaken opposition to Galileo. ‘Under the immediate shadow of the papal chair’, Italian intellectuals were less receptive to new ideas than those in Germany and Poland. Indeed, Protestant origins in Germany underscored that openness to new ideas at that time. However, Italian culture’s stern opposition to innovation also promoted a certain politeness when innovations did arise. Galileo thus presented his Copernicanism gently, and the Church responded with ‘courtesy and indulgence’, taking action against Galileo only when ‘compelled’.\textsuperscript{15}

Scripture posed the main conceptual conundrum, and Whewell presented a historical pattern of scriptural interpretation of nature. First, man inevitably read ‘the received philosophy of the time’ into such scriptural passages. With scripture’s meaning then

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interpreted to be that received philosophy, that scriptural connection increased opposition to new natural philosophical ideas. However, when finally the change occurred, one could see that both old and new natural philosophies were consistent ‘with the soundest religious views’. From that new perspective, however, the past proved tough to comprehend. Whewell’s generation, for example, ‘can hardly conceive how reasonable men’ could have opposed Copernicus on scriptural grounds. In such cases, ‘the world at large’ inevitably ‘strongly condemned’ past views. It was ‘the more considerate and serious’, Whewell obviously emphasized, who understood the conundrums of the history of such thinking and could thus rightly regard them ‘with pity’. Hence, although wrong, the Catholic opposition to Galileo did not deserve ‘the scorn and aversion of mankind’.16

Whewell’s brief history of the confrontation, thoughtful though it was, nevertheless presents it as Galileo’s ‘science’ of telescopic facts versus the Church’s ‘religion’ of outdated scripture. Although, as historians, we should understand Whewell’s presentation in his own historical context, we also realize that since Whewell’s day our knowledge and understanding of the Galileo affair has improved. Indeed, Whewell himself seemed to regard the Galileo affair as an exception, with science and religion generally residing in harmony with one another, as was certainly the case in his own mind.

However, my surmise is that Galileo’s perceived, Whewell-like link to science and the Church’s to scriptural religion long coloured even the best historical scholarship. Hard even to see were the Church’s scientific opposition to Copernicus, and Galileo’s religious support for Copernicus. Regarding astronomy, Galileo’s most scientific accomplishments were his telescopic observations, especially of Venus’s phases. Scholars accordingly concluded that the telescope provided the strongest evidence for the Copernican system. This clarifies the importance of William Shea’s 1972 book underscoring Galileo’s reliance on his Copernican theory of the tides.17 Even more surprising was Roger Ariew’s 1987 article showing that Venus’s phases actually required only a slight modification of even the Ptolemaic system.18 If one just makes the Sun the centre of Venus’s epicycle, then Venus orbits the Sun as the Sun orbits the Earth, all else remaining the same. We can still ask whether Galileo’s telescope even now blocks our view of valid meteorological objections to Galileo’s deepest telescopic conclusion. In other words, in the seventeenth century would the limited telescopic evidence opposing an Aristotelian celestial–terrestrial dichotomy have been successfully countered by ever-present, hard-to-predict meteorological phenomena? The telescope suggested similarity, but unpredictable weather contrasted sharply with predictable celestial phenomena. Whatever the answer to those questions is, abandoning the words science and religion my own summary of recent historical scholarship is:

The Church’s literal interpretation of Scripture conflicted with Galileo’s accommodation theory. What we might call the Church’s literal interpretation of experience conflicted with Galileo’s methodology of empiricism tempered by mathematical beauty. The Church’s Scripturally based belief in an omniscient God conflicted with Galileo’s theory of a man-like God, or God-like man—a theory undoubtedly understood by Galileo within the Scriptural context of God creating man in His image. Not man’s arms and legs but his mathematical cast of mind reflected Divinity.19

As is explicit in that quotation and as is encouraged by the historical examples of Galileo and Whewell, I am suggesting that we go beyond the wisdom of quotation marks to a set of words more comprehensive than science and religion, to a collection of words that more accurately maps past ideas. We could follow C. P. Snow and regard these words as
‘shorthand jargon’, as he did the helpful-but-imperfect words abnormal and normal regarding the complex personalities of Sir Henry Tizard and F. A. Lindemann. The history of science and religion—like the Scientific Revolution—will undoubtedly remain a convenient label, and science and religion may remain as brief references, as in the preceding paragraphs. At a more comprehensive level of historical accuracy, however, they can mislead. With their too-restricted meanings, they foster something like a Kuhnian, historical paradigm that can hinder historical research. Moreover, diagramming the alternative paradigm of a more comprehensive terminology requires one to be specific about relations of methods and ideas to one another.

On the left in figure 1 is a list of different ‘ways of knowing’. The terms are familiar enough to historians of science, and the list is neither exhaustive nor compulsory. Choosing between these possibilities for a diagram would reflect the person whose ideas were being analysed; similarly for the ‘objects of knowledge’ on the right. I suspect that much of historians’ wider audience conceives science to be an empirical knowledge of
nature and religion to be a scripture-based knowledge of God and related entities. The two arrows in the diagram represent that view. In excluding so much, the diagram in figure 1 has obvious limitations. It would exclude, for example, William Paley’s empiricist, design argument for God’s existence and Descartes’s rationalist argument for both God’s existence and a full material Universe. An analysis of Plato’s thought would have to add his non-material Intelligible World to the list of objects of knowledge. Such limitations raise the related questions of how historians should address general readers and how those historians would envisage a proper diagram—say of the ideas of William Whewell, as in figure 2.
Let me say something briefly about this collection of words and arrows. Whewell’s above-discussed correspondence and sermons certainly support the conclusion that scripture supplied Whewell with much sound knowledge. In opposition to William Paley’s utilitarian moral philosophy, he cited several biblical passages confirming the existence of conscience within the human mind—conscience containing moral laws ‘written upon the heart’. Ignorance of these innate truths by ‘savages’ (in the parlance of the day) did not undermine the existence of those inherent truths. Savages did not know Euclidean geometry either, but mathematicians had eventually defined that subject working from the inherent idea of space. It was not that moral philosophy depended on mathematics but that the mathematical analogy helped one understand the status of moral truths. Moreover, in addition to establishing the existence of conscience, revelation specified many moral truths. But again, as with geometry, philosophers such as Plato, employing conscience-based reason, could identify such moral truths independently of revelation. For Whewell, the emotion of happiness was the utilitarians’ misleading way of knowing moral behaviour. In reality, happiness was more an object of knowledge—a part of humans that resulted from moral behaviour. The emotion of pleasure, in contrast, was a partial guide to truths about nature. Man’s degree of pleasure in contemplating such theories suggested the likelihood of their truth, that role of pleasure depending on the similarity of God’s mind and man’s. Whewell argued for that similarity in his Bridgewater Treatise. Design in nature disclosed the existence of a designing God, who had also designed man’s morality and intellect, with man’s mind imperfectly mirroring God’s immensely superior mind. Scripture revealed the same truth. Indeed, William’s letters to Elizabeth also reflected this superiority of God, as an answer to the ongoing issue of human suffering. God was good, and thus whatever appeared bad to mankind was actually part of a Divine path to ultimate goodness. God was both the divine artificer of nature and the divine lawgiver. God’s ideas were the archetypes for man’s. Reason and especially revelation thus combined to provide a framework for Whewell’s philosophy of Kantian-like fundamental ideas, being God’s creation in man’s mind. In turn, those fundamental ideas yielded the certainty of the laws of motion. However, no Kantian-like doubt of a real, external world arose because revelation disclosed that God had designed man and nature for each other. And both empirical data and revelation reflected a God who could and did intervene in natural processes. Though Whewell’s Bridgewater Treatise on astronomy portrayed God the lawgiver, his writings on the history of life on Earth envisaged divine interventions. I have also included ‘Nation’ and ‘Afterlife’ in the diagram. In Whewell’s view, England was better suited than ancient Israel to propagate the true religion around the world, but England also suffered from the selfish, utilitarian search for superficial happiness. In instructing young men, universities carried much responsibility for maintaining the nation’s morality and thus its proper position in world affairs. Reforming moral philosophy at Cambridge, that is, had potentially worldwide benefits. Although a combination of revelation and reason defined this role for Cambridge, it was mainly revelation that told of the ‘eternal fulness’ or ‘eternal misery’ awaiting mankind.

The diagram in figure 2 is no substitute for a verbal explanation of the ideas involved. It does, however, force one to identify the relevant ideas and to be explicit in relating them to each other. And the process of constructing such a diagram can helpfully raise questions that might otherwise have remained unnoticed—by both historians and their readers.

Although such diagrams can be exceedingly helpful to us in sorting out historical ideas, I intend them also as a shock to historians’ wider audience’s understanding. Rather than
beginning with the words *science* and *religion* and crawling from them to a deeper meaning, I recommend that historians commence with a stark representation of that deeper meaning itself. The diagram underscores the required conceptual shift in our readers’ minds, hopefully more effectively encouraging that shift. In turn, that shift in historical understanding should contribute positively to current debates. Analysing the thought of the likes of Whewell is good practice for analysing one’s own. I do think that present-day discussions tend to concentrate on conclusions, downplaying or even ignoring the ways of reaching and supporting those conclusions. Asking someone how he or she knows that something is true can lead to insightful deliberations. In such matters, history does inform present understanding much more than the reverse. With that in mind, here briefly are four current arguments that I hear—with historical responses.

One faulty declaration is that *by definition* science does not include religion. If one means by ‘science’ something like an accurate understanding of the natural world, then this cannot be true. Given, for example, Whewell’s entangled mix of ideas, one obviously requires a counter-argument (not merely a definition) to thus separate science (whatever that is) from religion (whatever that is). If Whewell thought that not only revelation but also scripture-supported emotions and fundamental ideas shaped a proper understanding of nature, what is one’s refutation of his position?23

Second, because a particular religious view agrees with science, it is therefore true. But there are many ways—like Whewell’s—of achieving agreement between these different realms of human knowledge. Such agreement would not define a true religion very precisely. In addition, does one abandon the religious position when the religion-verifying scientific theory gets replaced? Moreover, what if the best ways of knowing God were superior to the ways of knowing nature? Then the true ‘religion’ could disagree with the very best ‘science’, forcing a reconsideration of the latter.

Third is the design-version of the strong anthropic principle that the Universe which emerged from the Big Bang is so ‘finely tuned’ that it must have been designed by an intelligence with humans in mind.24 But Whewell declared his quite different, non-Big-Bang, non-relativistic Universe also to be designed. Does the ‘design’ of quite different Universes undermine specific, present-day arguments? Or, more severely—to consider another historical example—if a God were designing a Universe for humans, would he not more probably have created Aristotle’s Universe than the Big Bang Universe? In Aristotle’s even older Universe, mankind has *always* been present and is not merely a recent blip. And humans are at the centre of Aristotle’s Universe, their Earth occupying a vastly greater proportion of their Universe than does our Earth. A creating God could have chosen to create the physics of Aristotle’s Universe, providing humans with a much friendlier home. If we did reside within Aristotle’s Universe, however, we would also have to contend with his arguments against the concept of divine design. ‘It must be of itself that the divine thought thinks (since it is the most excellent of things)’, Aristotle concluded, ‘and its thinking is a thinking on thinking.’25 That is, God’s contemplation of our imperfect, changing world would undermine his own perfect constancy. Only a kind of self-contemplation, Aristotle argued, would be logically possible for God—and certainly not design of our particular Universe.

Fourth, and of course most significant, is the ‘conflict thesis’ that science and religion have been and are mainly in conflict with each other. Although historians of science are well beyond this view, others are not.26 It is always the majority view of my students—at the beginning of the semester. But might even our ‘complexity thesis’ still contribute in a way to others’ misunderstanding? We may say that, in addition to being in conflict,
science and religion can agree with each other or be separate from each other and that one might be superior to or supportive of the other. But within that complexity, conflict remains a possibility—one that could occur more frequently than the others. However, as illustrated by Galileo and Whewell, the historical reality is that science and religion have invariably existed in harmonious combination for any one person and that any conflict then usually occurs more between different harmonious combinations, with the conflict being primarily between different versions of science and/or between different versions of religion—rather than simply between one person’s science and another person’s religion.

The usual, too-rigid, too-present-minded, science–religion paradigm may make this a difficult point to grasp. But I would say that thinkers such as Plato, Aristotle, Galileo, Descartes, Newton, Leibniz, Hume, Kant, Whewell, Darwin, Huxley, Jeans, Eddington and Einstein (and many more, of course) will form a coherent combination of some of the following: literal scripture, accommodated scripture, irrelevant scripture, no scripture, point god, spatial god, material god, designer-but-not-creator god, neither-designer-nor-creator-but-cause-of-motion god, intervening god, hands-off god, unknowable god, no god, non-existent material world, existent material world, unknowable material world, real non-material world, empiricism, rationalism, intuition, faith, and so on.

Hence an agnostic, for example, would, strictly speaking, be required to mount arguments against scriptural, empirical and rationalist arguments for the existence of a God, especially one who influenced the course of natural phenomena or who somehow shaped human knowledge to one degree or another. Of course, one might understandably reply that agnosticism is not ‘religion’. Well, neither is it ‘science’, but it would be an essential part of the debate and thus must be included for historical accuracy. Hence, more justification for the here-recommended, more flexible reconceptualization of the subject.

Even the modern creation–evolution debate would be a relevant example. That debate is not merely a conflict between science and religion but mainly between vastly different interpretations of scripture—that is, between different ways of knowing. Creationists conclude that biblical revelation would trump any empirical evidence for geological antiquity or biological evolution. In contrast, evolutionists regard the Bible—even if it is revelation—as irrelevant to their conclusions based on empirical evidence. However, if a scripture-rejecting, agnostic evolutionist did somehow become convinced that God through scripture instructed mankind that he created the Universe in more or less its present form merely 6000 years ago, then that evolutionist would legitimatly reinterpret empirical evidence. He might well conclude, for example, that God had created the light between stars and Earth 6000 years ago. Hence, a star might be billions of light years distant, but it did not take billions of years for the light we see to arrive.\textsuperscript{27} Or, just as that scriptural God could last month have created a tree with fifty rings, he could 6000 years ago have created the Earth with all its geological strata and fossil remains. That is, such a young Earth is conceptually possible. Hence, an evolutionist would, strictly speaking, be required to go beyond simply a list of empirical data to mount an argument against biblical revelation as a germane way of knowing.

Finally, given all the above, given the pervasiveness of the conflict thesis, and given historians’ understanding of historical complexity, what is the best single subject for conveying that insight to non-historians of science?\textsuperscript{28} The Galileo affair is my answer. It seems to be generally viewed by non-historians as a classic case of rigid religion suppressing true science. And it occurred long enough ago that our contemporary audiences will have much less at stake conceptually or emotionally than they would with subjects such as Charles Darwin or present-day creationism.
Indeed, my own course on the history of science and religion—and I am sure most other such courses as well—meets this objective. Galileo comes near the beginning of the semester and the more controversial subjects towards the end. For several years, I have found it very effective to retry Galileo.\textsuperscript{29} I lecture on the respective views of the Catholic Church and Galileo (without the words \textit{science} and \textit{religion} but with diagrams of their ideas). The students read the evidence for the trial outside class.\textsuperscript{30} I divide them into small groups and allow them part of a class period to discuss that evidence among themselves—without reaching any verdict (and without having read what the Church’s verdict was). I do explain that our procedure is quite different from that of 1633!

On the day of the trial itself, I begin as the ‘judge’. To set the scene I read a one-page statement. Addressing the ‘Lords and Ladies of the Holy Office’, reminding them of their ‘grave responsibility in this grave affair’, and presenting Galileo as ‘one of the brightest lights of Italian culture’, the statement concludes:

\begin{quote}
In summary, we must settle this matter as promptly as possible. We must give due consideration to the place of the Holy Church in European affairs and the role of the Holy Church in the salvation of the souls of Christendom. Given the prominence of the man before us and the momentous issues before us, be assured that your decisions here today—for better or for worse—will exert their influence in time and space far beyond these few moments and these four walls. For the sake of us all, may God guide your deliberations.

The question before you, therefore, is: did Galileo violate the injunction not to hold, defend, or teach the Copernican system?
\end{quote}

Then the students take over. I have one or two students be Galileo’s prosecution and another one or two (including a graduate student if one is in the class) his defence. The prosecution has five to ten minutes to make its case and the defence a similar time to respond. After another couple of minutes for each to make final comments, the rest of the class—as ‘jury’—gets to question the prosecution and defence. In a recent course, Galileo’s defender decided to be Galileo himself, and she performed excellently. There before me were thoughtful undergraduates pressing Galileo ‘himself’ on issue after issue.

The jury then deliberates. Although they ask questions individually, they deliberate in their small groups. This, of course, requires them to discuss the issues and to defend their thoughts on the matter, as their group reaches verdicts as to Galileo’s degree of guilt (or innocence) and his proper punishment (or freedom). The prosecutors and defenders circulate among the groups continuing to be as persuasive as possible.

So far, our Galileo has suffered nearly the same fate as Galileo himself, being found guilty of \textit{slight} suspicion of heresy and placed under house arrest.\textsuperscript{31} Galileo was found guilty of \textit{vehement} suspicion of heresy, resulting in house arrest. After the first couple of trials went this way, I added the provision that the jury could declare Galileo innocent because he did support the Copernican system and was \textit{right} to do so. Compelling arguments for Galileo’s innocence could require a reinterpretation of scripture or a re-evaluation of long-trusted empirical evidence. That has not changed the outcome. After declaring the verdicts, we spend some time discussing the students’ own reasonings in the matter, as well as the fate of Galileo himself. At this point, having at first voted overwhelmingly for the conflict thesis but now having thus grasped much of the complexity of the Galileo affair, the class is ready for the rest of the course—with a properly complex version of the complexity thesis in mind.
To conclude, I am advocating a reconceptualization of the subject of the history of science and religion. This approach would aid historians’ own research and strengthen their message to others—both academics and non-academics—with regard to both the past and the present. It is an approach perfectly illustrated by the ideas of, among many others, Galileo and William Whewell, Lancastrian ‘scientist’.

Acknowledgements

This is a revised version of the talk that I presented at the Conference on Science and Religion held at the University of Lancaster in honour of John H. Brooke. My title then was ‘Reconceptualizing the history of science and religion: the example of William Whewell, Lancastrian “scientist”’. ‘Reconceptualizing the subject’ was one of the themes of the conference encouraged by the conference’s organizers. Some of the papers presented at the conference have been published.32 For permission to quote from manuscripts that they hold, I am grateful to the Syndics of Cambridge University Library and to the Master and Fellows of Trinity College, Cambridge. My research has been assisted by a Senior Fellowship at the Dibner Institute for the History of Science and Technology, a research grant from Iowa State University’s Center for Excellence in the Arts and Humanities, and the Eleanor Searle Visiting Professorship in the History of Science at the California Institute of Technology and the Huntington Library. Julie has provided invaluable advice, and I have had helpful comments from anonymous reviewers. I would also mention my superb grade school English teacher at Dexter School, who taught us how to diagram sentences.33 I am indebted to Martin Teply for preparing the two computer-generated diagrams.

Notes


Whether Whewell’s ‘subject’ refers here to religion generally or to the specific religious topic of his brother’s poetry, I judge Whewell’s word ‘awful’ to mean ‘awesome’—perhaps
dauntingly awesome—but not ‘terrible’. There were multiple meanings for the word: ‘causing
dread; terrible, dreadful, appalling’ being one and ‘solemnly impressive; sublimely majestic’
being another. See James A. H. Murray (ed.), A new English dictionary on historical
examples from 1660 to 1853, the latest being: ‘How awful to feel himself there . . . an atom
amidst the infinity of nature’. See also the online Oxford English Dictionary.

Even more relevant is the ‘Conclusion’ of William Paley’s Natural theology, a pervasive aspect
of Whewell’s culture. Paley re-emphasized the significance of the design argument for God’s
existence, especially listing aspects of the human anatomy. Hence, a shift: ‘Whereas formerly God
was seldom in our thoughts, we can now scarcely look upon any thing without perceiving its relation
to him’ (William Paley, Natural theology; or, evidences of the existence and attributes of the Deity,
especially may this difference be perceived, in the degree of admiration and of awe, with which
the Divinity is regarded, when represented to the understanding by its own remarks [i.e. the
works of nature] . . .’ (ibid., p. 540). Comprehending God in this way ‘facilitates the belief of the
fundamental articles of Revelation’ (ibid., p. 542), which, in turn and most importantly, allowed
man to move beyond ever-present, familiar, material analogies to a true understanding of ‘the
resurrection of the human dead’ (ibid., p. 543). As wonderful as it would be, such a huge
transformation from paying little attention to God to understanding divinely promised resurrection
might seem unlikely. However, remember, Paley answered, the two-hour-old child will eventually
understand calculus (ibid., p. 547). ‘Upon the whole;’ Paley began his final paragraph, ‘in every
thing which respects this awful, but, as we trust, glorious change, we have a wise and powerful
Being . . .’ (ibid., p. 548). (My italics.)

Whewell himself used the word similarly in a sermon he delivered in 1827. He began his sermon
as follows:

‘The works and word of God are full of objects which may well afford inexhaustible matter for
the devout admiration of us his servants. We have the frame of the material world, beaming with his
glory wherever we turn our eyes:—we have his scriptures, offering to us with respect to our own
nature, the wisdom of him who made us what we are:—we have his eternal and merciful
dispensation for the redemption of man, spread out before us. These are things on which our
thoughts and our feelings may long and deeply dwell. We have too, pressing with an imperious
urgency upon our hearts, the interests and cares of our individual salvation;—the hopes and fears
which belong to our X\textsuperscript{n} condition;—the great business of our acceptance with God,—of our self-
examination, discipline and advancement toward X\textsuperscript{n} perfection;—of our destiny and employment
in a future life.

‘The practical consideration of these awful subjects may well fill the believer’s mind and engross
all his attention’ (Whewell, ‘Sermon delivered on 4 February 1827 at St. Mary’s Church,
Cambridge’, Whewell Papers, Trinity College, Cambridge, R.6.17\textsuperscript{13}). (Italics mine.)

See also Thomas Chalmers, A series of discourses on the Christian revelation viewed in
connection with the modern astronomy (William Collins, Glasgow, 1834), pp. 138–139.

3 Mrs Chapone, Letters on the improvement of the mind: addressed to a lady (J. Walker, London,
1810), pp. 7–8, 113 and 2, respectively. Hester Chapone (1727–1801) was a well-known
advocate for women’s intellectual and emotional rights, and Letters was her most successful
book. See Rhoda Zuk, ‘Chapone (née Mulso), Hester’, Oxford dictionary of national

4 Whewell to Mrs. Lyon, 12 July 1820, Whewell Papers, Trinity College Library, Add.
Ms.a.273\textsuperscript{52}. This letter is not included in Stair Douglas, op. cit. (note 2).

5 Whewell to Elizabeth Whewell, 28 February 1820, Whewell Papers, Add. Ms.a.273\textsuperscript{45}. In Stair

6 Whewell to Elizabeth Whewell, 26 November 1820, Whewell Papers, Add.Ms.a.273\textsuperscript{61}. In Stair
Douglas, op. cit. (note 2), p. 63. The published version omits the rest of the paragraph following
Whewell’s reference to ‘day spring’. It reads: ‘Your affliction and your gloom my dear sister have been dark & heavy enough, and though we grieve without measure we cannot but rejoice that God, in his chastening, has also shown his love. May he still console and comfort you and if it please him diminish your sorrows here.’


18 Roger Ariew, ‘The phases of Venus before 1610’, *Stud. Hist. Phil. Sci.* 18, 81–92 (1987). One problem for Ptolemaic astronomy before 1610, Ariew writes, was whether Venus was ‘above’ or ‘below’ the Sun. Galileo’s telescope thus provided an answer to this ongoing issue within Ptolemaic astronomy.

19 David B. Wilson, ‘Galileo’s religion *versus* the Church’s science? Rethinking the history of science and religion’, *Phys. Perspect.* 1, 65–84 (1999), at p. 82. If required to use those imperfect words, I would argue that both Galileo and the Church unified one version of science and one version of religion and that the conflict was much more between science and science (the Church’s scripturally and empirically supported, Earth-centred Universe versus Galileo’s scripturally and simplicity supported, Sun-centred Universe) and between religion and religion (the Church’s literal scripture and different-from-man God versus Galileo’s accommodated scripture and somewhat-similar-to-man God) than it was between science and religion. The deepest conflict, I would say, was that between religion and religion.

Avoiding those words, I have similarly summarized current scholarship on the related-to-Galileo, early-eighteenth-century Leibniz–Newton confrontation as follows: ‘Somewhat like Galileo, Leibniz concluded that logical thought disclosed God’s own logic to man and that a
logical God would create a logical world. Somewhat like the Catholic Church in opposition to Galileo, Newton concluded that experience and scripture combined to reveal much about God and that an all-powerful God could choose the kind of world he wanted to create’ (David B. Wilson, *Seeking nature’s logic: natural philosophy in the Scottish Enlightenment* (Pennsylvania State University Press, University Park, PA, 2009), p. 32). The word *somewhat* does indicate that significant similarities hardly entailed total agreement.


21 This was a quite different view from those of Leibniz and Voltaire, for example. In Leibniz’s rationalist conclusion that this was the ‘best of all possible worlds’, bad things really were bad. It was just that in any other possible world, things would be even worse. In Voltaire’s empiricist approach, bad things were so bad that one could easily imagine a much better (and possible) world.

22 Although long, this paragraph is obviously not intended to be an exhaustive discussion of Whewell’s ideas. For somewhat longer discussions and for guides to the larger literature on Whewell, see three recent brief biographies: Richard Yeo, ‘Whewell, William (1794–1866)’, *Oxford dictionary of national biography*, vol. 58, pp. 463–470 (Oxford University Press, 2004); Glenn M. Sanford, ‘Whewell, William (1794–1866)’, *The dictionary of nineteenth-century British scientists*, vol. 4, pp. 2139–2145 (Thoemmes Continuum, Bristol; University of Chicago Press, Chicago, IL, 2004); and David B. Wilson, ‘Whewell, William’, *New dictionary of scientific biography*, vol. 7, pp. 279–283 (Charles Scribner’s Sons, Detroit, MI, 2008).

After presenting my paper at the Lancaster conference, I received helpful questions about the diagram in figure 2. In answer to one question, I emphasized that this diagram is specific to Whewell’s ideas and is not intended to apply to everyone. A diagram’s specific lists of ways of knowing and objects of knowledge (and the connections between them) depend entirely on the person’s thought being analysed.

Matthew Stanley and Geoffrey Cantor asked whether such diagrams could not justifiably be even more detailed and complex, and I agreed with both. Stanley suggested that the diagram could be made to show which ideas were most *strongly* endorsed by the person in question, and I think that this could be done by varying either the thickness or colour of the arrows accordingly. Cantor asked about *tension* existing between ideas within the same conceptual system. Such tensions invariably exist, and I think that they could be highlighted by drawing additional ‘tension’ arrows of some kind between different parts of the diagram.

For my diagram of the ideas of Sir George Gabriel Stokes (1819–1903), see ‘Sir G. G. Stokes—scientist and Victorian’ ([http://www.newton.cam.ac.uk/webseminars/stokes/wilson](http://www.newton.cam.ac.uk/webseminars/stokes/wilson)), a talk delivered on 18 March 2003, for the centenary of Stokes’s death.

23 This paragraph is but a brief statement of the central point made at greater length by Matthew Stanley in the paper that he delivered at the Lancaster conference.


Frank Turner asked this question after I delivered my paper at the Lancaster conference. I here give a longer answer than I did there.

I first did so in a course on Galileo that I team-taught with the philosopher Michael Bishop, then a member of Iowa State’s Department of Philosophy and Religious Studies.


Relying on Finocchiaro’s *The Galileo affair* for definitions, if the students find Galileo guilty, they can choose between three degrees of guilt: formal heresy, vehement suspicion of heresy, and slight suspicion of heresy. If they do not free Galileo, they have three punishments: burn him at the stake (I mention Giordano Bruno), imprison him, and place him under house arrest. In the last seven times that I have taught the course (from 1998 to 2011), there have been altogether 48 voting groups of students; 29 found him guilty of slight suspicion, 12 found him guilty of vehement suspicion, 3 found him guilty of formal heresy, and 4 declared him innocent. For punishment, \( \frac{31}{2} \) voted for house arrest, 7 for prison, \( \frac{7}{2} \) (obviously one group was severely split on the matter) for freedom, and 1 for burning at the stake. In each of these cases, they had the option of finding Galileo innocent because he and Copernicus were correct. For a study of retrying Galileo in a quite different sense, see Maurice A. Finocchiaro, *Retrying Galileo, 1633–1992* (University of California Press, Berkeley, CA, 2005).


For another example of diagramming concepts, see Joseph D. Novak and D. Bob Gowin, *Learning how to learn* (Cambridge University Press, 1984), brought to my attention by Martin K. Nickels.