Stillman Drake's Intellectual Legacy

As they are read today, the study of the works of Galileo is synonymous with Stillman Drake, twenty-three years after Drake's death in October 1993. Drake gave us, in 1953, the first English translation since the 17th century of Galileo's *Dialogues Concerning the Two Chief World System*s. This book was the first of a series of translations and studies ("gleanings") that likely brought Galileo's works to more people than they had reached during the first three centuries after they were written. Including his translations, Stillman wrote 16 books on Galileo, contributed to 15 others, and produced over a hundred scholarly articles.

In 1976, Drake published translations of two early satires by Galileo, under the title *Galileo Against the Philosophers*, which attacked philosophers for their interpretation of the new star of 1604. Stillman's own opinion of academic philosophers, present as well as the past, was much the same as Galileo's, though, like his champion, he himself had trained in Philosophy. Stillman's legacy for the history of science at IHPST and beyond is evident to many who are here today in celebration of the 50th anniversary of IHPST, but his impact on philosophy is under-appreciated and I will have more to say about Stillman and academic philosophy later in my presentation.

Stillman's most popular book, and one of the two or three best sellers in the history of science, was his *Discoveries and Opinions of Galileo*, published in 1957, which contains translations of most of the *Starry Messenger, The Letter to the Grand Duchess Christina*, excerpts from the *Letters on Sunspots*, and the *Assayer*, along with other documents and letters in the introduction to each work. Later in 1960, Stillman published a complete translation of the *Assayer* in the *Controversy on the Comets*, and in 1983 (with C. D. O'Malley), he produced the

most affable of his many books, *Telescopes, Tides, and Tactics*, in which he embedded a reading of the *Starry Messenger* in an authentically Galilean dialogue between Salviati, Sagredo, and Galileo's old friend from the Veneto, Paolo Sarpi.

The most intellectually challenging of Galileo's works, presenting his discoveries in mechanics, and his most concerted attack on Aristotelian and Scholastic natural philosophy is the *Discourses and Mathematical Demonstrations Concerning Two New Sciences Pertaining to Mechanics and Local Motion*, which Stillman translated and published in 1974. Drake had already published in 1960 (with I. E. Drabkin) translations of the early tracts *On motion* and *On Mechanics*, as well in 1969 translations of writings on mechanics by Tartaglia, Benedetti, and Ubaldo, but with the translation of *Two New Sciences* and his continuing work on Galileo's manuscripts, mechanics became the focus of Stillman's work after 1974 and the foundation for Drake's authoritative *Galileo at Work: His Scientific Biography*, which was published in 1978. *Galileo at Work* is the finest and most comprehensive study of Galileo in print and, I would suggest, a veritable Citizen Kane of scientific biography. Here we find a clear presentation of the many challenges that Galileo faced in describing continuously accelerated motion: although Galileo's mathematics did not countenance the formation of ratios between quantities of unlike kinds, such as distance and time, Galileo nevertheless produced a consistent system based on novel procedures for comparing continuously changing quantities with one another.

Stillman's intellectual legacy will be evident to many in this room who are historians of science by training. Stillman's careful analysis of primary source material and his appreciation of the difficulty involved in understanding older ways of reasoning made a lasting impression on the first generation of IHPST junior faculty and, though their involvement, on the work of their students, many of whom are here today. There are many examples of Drake at Work, but the

classic example of Drake's historical imagination and the deployment of his formidable tools of historical analysis is his treatment of Galileo's proof that the speeds of falling bodies cannot be proportional to the distances fallen. Though Salviati presented this proof as intuitive and obvious, it was criticized by Galileo's contemporaries on its publication and, more recently, by the well-known Newton scholars I. Bernard Cohen and A. R. Hall. Indeed, this proof is still the subject of controversy, though the learned consensus is that Drake was correct after all to argue, in his definitive 1970 article on this subject, that failure to appreciate the soundness of Galileo's proof was occasioned by two related failures: (1) a faulty translation of the Italian term "velocita" (which, as Drake noted, did not excuse those who read, or should have read, the original Italian, which would help them discern that in its context the term denoted "speeds" (not speed); and (2) failure to consider the proof in its context and to grasp the precise line of Galileo's thinking in it. Galileo's precursors had noted that heavy bodies speed up as they fall, but were indifferent as to whether one ascribed this increase of speed to the distances through which bodies fell or to the times it took them to do so—the two were thought to be equivalent, or rather, no one seems to have given a thought to whether in fact they were equivalent or not. Drake traced in detail, largely from Galileo's unpublished notes on motion, the chain of reasoning that led Galileo eventually to recognize the essential difference between distance-proportionality and time-proportionality for accelerated motion, and to determine that naturally accelerated motion was in fact time-proportional. Galileo's subsequent definition of uniform acceleration as the increase of speed in proportion to time came to constitute the main premise of his new science of motion, which he presented as a deductive science in a Latin treatise embedded within an Italian dialogue, the second of the two new sciences in his *Discourses*

Concerning Two New Sciences. Galileo's achievement is well-documented in Roy Laird's article, "Stillman Drake on Salviati's Proof" (*Centaurus*, 2012).

This legacy to historians of science is evident in the *feschrift* to Drake, *Nature, Experiment, Science*, edited by Trevor Lever and Bill Shea. Among others, this volume contains papers on Renaissance astronomy, Lavoisier's contributions to the chemical revolution, the inductive sciences in 19th century England, Darwin's work in 1835-1837, and the background to Hertz's experiments in electrodynamics. In the Eloge to Stillman published in *Isis*, Jed Buchwald and Noel Swerdlow remind us that Stillman greatly admired Heinrich Hertz, whom he regarded as having attempted to fulfill Galileo's image of a science without "spooky" things like forces. Still, many of these papers in this *feschrift* are far removed from Drake's own work. One might expect as much from the festschrift genre, but this collection provides ample evidence that Drake inspired or indirectly influenced many historians of science.

Stillman's legacy for philosophers is a more delicate matter to discuss and, as his successor at IHPST, it is something that I have struggled with on and off for many years. For those of us who were philosophers by training, and fortunate enough to have read his works early in their careers, Drake's work provided a striking counterpoint to the prevailing view of the scientific revolution, promulgated by Alexander Koyré, that the scientific revolution was a philosophical achievement, involving the geometrization of space and, its fellow traveler, the so-called mechanization of nature. For Koyré, Galileo's work and, more generally, the scientific revolution had precious little to do with experiment. Philosophers, who have always been much enamored of theory (or, as Ian Hacking would say, "representations," were blissfully unaware for the most part that Drake had established beyond any reasonable doubt that Galileo was indeed a skillful practitioner of the art of experiment and measurement, effectively overturning Koyré's

interpretation of the scientific revolution as a philosophical achievement. Drake's novel suggestion that Galileo's new science of motion and, indeed, the creation of early modern science should be seen in terms of the rise of a new and vital experimental culture reached mainstream academia at about the same time as the second, and most widely read edition, of Thomas Kuhn's *The Structure of Scientific Revolutions*. With its challenge to the privilege traditionally given to scientific theory, many philosophers of science set themselves the task of sorting out how, if at all, these new mega units of analysis, could be reinterpreted so that they did not clash with traditional portraits of the rationality of historical change in science.

For most philosophers of science, Drake's message about the importance of experiment as a tool to produce stable and reproducible results was lost. There were notable exceptions: Ian Hacking (1983), for example, argued persuasively that philosophers of science should forego issue pursuant to representation and reconceive their philosophical problems in terms of experimental tools that enable scientists to manipulate and control phenomena. Hacking has always been a trail-blazer: what was a beaten path is now a veritable expressway.

There were a handful of philosophers in Canada who were much taken with Drake's work, both in itself as the apex of Galileo scholarship, but also because they recognized that if they were going to come to grips with the work of Isaac Newton, the yardstick against which all accounts of revolutionary change is measured, they would need to study the works of Galileo and, as I said, the work of Galileo for modern readers is synonymous with the work of Stillman Drake. I could mention a number of Canadian philosophers who benefited from Drake's legacy – Joe Pitt, Bill Shea, and Francois Duhesneau, come to mind. All self-describe as HPSers, but they come to their studies as historians of philosophy and, it should be noted, for the historian of philosophy, Drake's detailed reading of primary source material is second nature.

Stillman may have had his issues, as did Galileo, with academic philosophy, but he did not hide in the nuances of micro history and, I would argue, was the strong proponent of a philosophy of science that is very much the fashion these days. As Buchwald and Swerdlow remark in their *Eloge*, Drake had no patience for the abstractions of modern cosmology, which he regarded as in a steep decline, and regarded science as a purposeful activity carried out by skilled craftsmen and women who knew how to produce effects and how to measure these effects. This, at the end of the day, is Stillman's legacy. It is legacy for historians and philosophers alike.

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