PRELUDE

The world's great age begins anew,

The golden years return,

The earth doth like a snake renew

Her winter weeds outworn.

Percy Byshe Shelley, *Hellas.*

The revival of classical influence in seventeenth century Italy had the effect of arousing increased interest in the sciences as well, reflecting the philosophical intellect and curiosity that had led also to the formation of notable collections in privately owned museums by those having the capital to invest. Among the first collections to be favored were classical antiquities, then fine arts and numismatics, and in due course, collections expanded to include natural curiosities as well. These ranged from unusual items found in nature such as ostrich eggs and stuffed crocodiles to minerals. As exploration and discovery expanded the horizons of the known world, considerable interest began to be generated also in artifacts from other climes and other times of ancient civilizations as well as those that were remote, brought back by explorers and missionaries. Eventually to be added to these were man-made curiosities, such as planetary models, clocks, automata and scientific instrumentation, and these were featured in what became known as the "Wunderkammern" or "cabinets of curiosities," which became the prerogative of the privileged and wealthy.

As the seventeenth century advanced, it gave birth to new sciences and new tools to serve the men of science, thus signaling an end and at the same time a beginning to some aspects of horology and scientific instrumentation. As interest waned in the traditional instruments that had dominated

scientific preoccupation in the late Middle Ages and the Renaissance – the astrolabes, nocturnals, quadrants, sundials, globes, and armillary spheres – interest turned to new scientific interests as they were being born, and invention of the tools to be used with them.

Emerging studies in natural philosophy, having brought with them the need for new means of measurement and observation, which made possible even greater precision by the invention of logarithms, calculus and the slide rule. Existing instruments were again reviewed and occasionally revised into new tools to serve new purposes, and when not adaptable, were replaced with inventions to fulfill them. Inevitably, the new sciences brought about the development of entirely new instruments. Of particular importance among them were the thermometer and barometer, and the pendulum-regulated clock, all contributing to increasing knowledge of man's world. Of yet greater significance, however, were the inventions of the telescope and the microscope, for they not only enlarged man's vision of his own world, but also introduced him to other worlds that had existed beyond the beyond, and hitherto had remained unknown to him.

Consequently, the traditional instruments, chiefly made of brass, gradually were augmented and sometimes replaced by new types made of glass, and to the skills of the brass founder and the engraver were developed those of the turner and glassworker. Concurrently, the major centers for makers of mathematical and horological instrumentation that had traditionally flourished in southern Germany and the Low Countries, gradually were replaced by others in Italy and France and somewhat later in England. The impact on scientific instrumentation elsewhere in Europe in the second half of the seventeenth century was brought about to some degree from immigration of foreign craftsmen. The end of the Thirty Years War, which had brought such dire effects on the great traditions of production of clockwork and scientific instrumentation in Germany and the Low Countries, drove many of their professionally trained artisans to seek

employment wherever it could be found elsewhere in Europe. In Italy some succeeded in establishing themselves at princely courts in major cities, often introducing new techniques as they practiced their skills. Clocks and instruments produced in Italy during the latter half of the seventeenth century often bore foreign names. Notable among the foreign clockmakers were several generations of the Ertel family who served as clockmakers at the Vatican. Also occasionally employed at the Vatican was Adam Heroldt, a German instrument maker who immigrated from Augsburg where he had been trained in his craft.

New instruments requiring glass commanded other skills, some of which had to be borrowed from other crafts. The skills and techniques of the spectacle makers and of the polishers of mirrors and *pietre dure* mosaics, for example, contributed to the production of optical lenses, while the talents of the cardboard makers and bookbinders served for the construction of tubes for early telescopes and microscopes.

In the field of horology, considerable innovation was achieved as well during the same period. The early clocks and neck watches that had been toys of the privileged had served less for time measurement than as visible symbols of status and wealth. A characteristic to be noted in sixteenth and seventeenth century portraits of the prominent is the frequency of the presence of a timepiece, either a clock upon the nearby table, a neck watch around the subject's neck or a sundial near his hand. A timepiece is particularly to be noted in portraits painted by Titian, for example, in which what appears to be the identical gilt brass table clock is present, suggesting that it might have been the artist's studio prop. The invention of pendulum-regulated clockwork early in the second half of the century soon brought about other horological inventions advancing the measurement of time, and eventually made possible time telling by everyone.

In due course, men of science arrived at the realization that the study of natural wonders

now was becoming a more responsive source of research, made possible by visibility provided for the first time by means of the new optical instruments. Consequently, the activities of even the ubiquitous amateur collector as well as those of the scholar began to assume greater significance. The growing interest in the new optical instruments, generated after mid-century by Galileo's observations of outer worlds, and discoveries of the heretofore hidden inner worlds revealed by the microscopes of van Leuwenhoek and Newton, elevated man's knowledge to a new plateau of learning.

Early contributors to the development of optical instrumentation included the pioneering Francesco Fontana in Naples, Carlo Antonio Manzini in Bologna, and Evangelista Torricelli in Florence, with subsequent substantial advances in Rome by Eustachio Divini. Not long after he had become engaged in optical instrument making, Divini's achievements with both microscopes and telescopes brought him renown, and for a time he remained in the forefront of the field. By 1646 he already had experimented with making microscopes and was among the first to develop the innovative new form of a compound microscope having sliding tubes, followed soon after by his invention of a doublet lens for the microscope eyepiece. Divini's work in the production of telescopes in the same period resulted in the publication in 1649 of a remarkable new map of the moon, based upon observations he had made with telescopes of his own construction.

Most frequently, throughout the second half of the seventeenth century in Europe, achievements in the production of instrumentation for the new sciences derived from patronage of the users of the new tools, chiefly eager young observers who had become aficionados of the popular and fashionable new preoccupation.

In Italy, a country segmented into numerous small city states derived from principalities and duchies, patronage limited the available market. Their courts, each as selfishly self-sufficient

and equally suspicious of each other, provided the primary sources of employment. As applicable in the seventeenth century as when he wrote *The Prince* a century earlier, was Niccolo Machiavelli's description of patronage in his classic work on court manners under absolute princes. "It is in the royal interest to keep everyone suspended between fear and hope," he stated, and went on to describe "the natural instability of favour is in the interest of the powerful." He cautioned that the successful competitor for what he described as "the fruits of servitude," which were to be gained from princely patronage, was constantly exposed to danger from potential whimsical changes of princely interest.

In seventeenth century Italy, when the pursuit of knowledge – particularly of the newly born sciences – began as a private enthusiasm, patronage was derived chiefly from the educated wealthy intellectuals, ranging from heads of state, the higher echelons of the Church and members of the nobility. The scholars and wealthy amateurs engaged in such pursuits, as well as the artisans who provided them with the tools they required, having to rely on them for employment, depended almost entirely upon their patronage. Skilled artisans generally worked independently of each other and jealously guarded the secrets of their crafts, leading to strong competition for favorable attention and financial support. The most talented sought the courts that appeared to demonstrate interest in the practical sciences and presented the greatest support for them.

Florence emerged as one of the major centers for scientific endeavor at that time, fueled by the combined interests in the arts and sciences of Grand Duke Ferdinand II and several of his brothers. In Rome, meanwhile, patronage was limited primarily to the circle of the papal court. Its assemblage of wealthy prelates, foreign embassies, and local nobility, in addition to academic centers such as the Sapienza University and the Collegio Romano, provided a platform for the

pursuit of the new sciences.

By the final decades of the sixteenth century, Florence already had developed an ambience particularly stimulating to scholarship, although less productive perhaps in other aspects. This was due to a decline in the economy from the level that previously had been achieved by Grand Duke Cosimo I. The arts and sciences again flourished under ducal patronage by the reign of Cosimo II, who had studied mathematics with Galileo. Thereafter, the pursuit of the sciences, which brought about the development of new instrumentation to achieve it, was strongly influenced by the interest of the Medici princes, led by Grand Duke Ferdinand II and his brother Prince Leopold, and Prince Mattias as well, and briefly by the short lived activities of the Academia del Cimento.

Scientific activity did not end in Florence with the demise of the Academia, however, for the Academia's motto, "*Provando e Riprovando*," still continued thereafter to reflect the interests of the Grand Duke Ferdinand II and his brother, as they corresponded with men of science throughout the European world and supported makers of instruments and clocks. Their brother, Cardinal Giovanni Carlo, arranged to have the barometer experiment performed in the presence of three notable men of science in the city at that time – Athanasius Kircher, Niccolo Zucchi, and Emanuel Maignan.

An outstanding case of successful manipulation of patronage in that period was reflected in the career of Galileo Galilei, an example from which many who followed were to profit. His achievements were derived from a combination of the sense of the practical emanating from acute observation, evaluated as first hand familiarity or knowledge with available techniques and processes, and his ability to recognize and utilize them. A master of rhetoric and persuasion, Galileo could be said to have created a new philosophy, and became widely recognized for his skillful political maneuvering of patronage. It was by means of it that he achieved what Mario

Biagoli was to describe as “an ability to create a new social professional identity for himself” ---- by having his current appointment as a professor of mathematics in Padua escalated to that of court philosopher and mathematician to the Medici court.

That there may have been less scientific activity in Rome during the second half of the seventeenth century to a degree may have been a consequence of the persecution of Galileo by the Church. Nonetheless, works on scientific subjects from time to time continued to be published. To avoid the possibility of censorship, however, frequently they were dedicated to a member of the curia or one of the incumbent pontiff’s nephews. By this means the author felt relatively safe in expressing ideas that previously had brought official frowns. Thus evidence was provided that the new science being expounded was receiving favorable consideration from higher ecclesiastical levels. A number of distinguished prelates in this period also were among the interested amateurs of the sciences. Notable among them were papal nephews, Cardinal Francesco Barberini and Monsignor Antonio Barberini and later also Cardinal Flavio Chigi and his cousin Prince Sigismondo. The mercantile activity of savants and amateurs that had been well developed, diminished substantially thereafter as the studios of academicians and savants failed t survive as commercial enterprises as had those of the professionals, although such activity did not disappear entirely as the production of lenses was undertaken by amateurs but without a lucrative result. By that time knowledge of theoretical optics had become widespread based upon the publication of the *Dioptrics* of Johann Kepler.

The formation of the earliest Italian scientific societies, in Rome and in Florence also added substantial impetus to scientific experimentation, demonstration and observation with the new instruments. In Florence they had become the concern of the Academia del Cimento, and flourished for a limited time with the support of the Grand Duke and Prince Leopold. Somewhat

later in Rome scientific experimentation and demonstration in particular were supported by the Academia Fisicamatematica Romana, established by Monsignor Giovanni Giustino Ciampini, with token patronage of Queen Christina of Sweden.

Each new scientific discovery created a need for even greater precision of measurement, and instruments of increasing sophistication became essential in achieving it. The acute observation and intellectual speculation of the men of science upon becoming combined with the ingenuity of the instrument makers succeeded in the production of the innovative tools of science needed to be applied to the emerging experimental and applied sciences that contributed substantially to the Scientific Revolution, and finally to the emergence from the man of science to scientist.

Innovative optical instruments, and the new sciences to which the mathematical practitioners applied them, bridged the gap between the development of the traditional instruments that had been achieved by the late medieval period and the Renaissance, and the application of precision measurement that was responsible for the rapid growth of experimental and applied science. Credit is due in part to Galileo as an example, who was among the first to combine theoretical appreciation of precision tools of science with the practical ability not only to design and/or construct them as need arose, but also to use them intelligently. Above all, Galileo was a master of promotion, not only of his own status, but of his scientific interests as well.

Although the telescope and microscope had been invented in the Netherlands, Italy almost imperceptibly became the center for the development of new optical instrumentation for the sciences of astronomy, botany, and medicine. This development was influenced by two factors, the first being the considerable publicity attending the publication of Galileo's *Siderius Nuncius,* possibly the most famous scientific book for a century, which moved Italy into the forefront of the

further development of optical instruments. The second factor was economic; for centuries the foremost glassmaking centers had been Murano and Venice, and later Florence. Their trade secrets were jealously guarded by the skilled glass workers and mirror polishers, enabling Italian glass to remain unsurpassed despite persistent but unsuccessful efforts by other countries, particularly France, to achieve a comparable product.

Successful scientific experimentation was contingent upon not only use of the technology available, but also upon the ingenuity of those men of science who defined the requirements for instruments and then combined with the talents of those artisans who made them. Inventors of new instrumentation derived from varied disciplines, some from military engineers, some occasionally coming from religious teaching orders, as well as from the ranks of independent scholarship. For the first time, the man of science – it was still too soon for the "scientist" to have emerged – achieved status, and he in turn recognized and acknowledged the role of the instrument maker as more than a mere craftsman. The inbred snobbery of the scholar for the artisan was on the wane, as in his writings Galileo again and again had noted that he had derived the stimulus to intellectual speculation from instruments and from discussions with the skillful craftsmen who made them in the arsenal in Venice. In England, William Gilbert sought some of his apparatus from sea captains and instrument makers, while Robert Boyle repeatedly admitted that he had learned much from artisans. Later still, Giovanni Domenico Cassini cooperated constantly with Giuseppe Campani, his friend and maker of the lenses and telescopes with which he made his discoveries, and engaged with him in mutual observations.

It was a time when makers of astronomical instruments frequently used their own new instruments to independently accomplish important observations, the record of which occasionally achieved publication. The names of this new role of the maker-observer, such as were Eustachio

Divini, Christiaan Huygens and Giuseppe Campani – appeared with growing frequency in the scholarly publications of the period, with discussions of both the instruments and the observations made with them. With few exceptions, the instrument makers and clockmakers had emerged from small rural communities far distant from a metropolis, many without facilities for advanced education beyond schooling by the local parish priest. The presence of educated members of the priesthood in the Italian provinces undoubtedly was responsible for occasionally identifying particularly talented and ambitious youths in their parishes and encouraging them to seek fulfillment afield.

It is remarkable how the Campani brothers, emerging from a remote tiny hamlet high in the Umbrian hills, managed so quickly to become central figures in one or another of the sciences of their time shortly after their arrival in Rome. It was an exciting period of achievement in the arts and letters. It was the time of invention of pendulum-regulated clockwork, of the barometer, thermometer, telescope, and the microscope, all of which were to expand man's world, and to all of which one or another of the Campani brothers contributed.

It would seem to be no great exaggeration to claim that Giuseppe Campani's leap to fame from a boyhood in the rock-ridged Umbrian hills to being granted papal patents for his horological inventions and also achieving wide acknowledgment as Europe's foremost telescope maker, was in fact, the direct consequence of the insomnia of a newly-elected pontiff. And it is there that his biography truly begins.