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Amid all the causes of the destruction of human property, it seems to me that rivers hold the foremost place on account of their excessive and violent inundations. . . . A river which is to be turned from one place to another must be coaxed and not treated roughly or with violence.

—Leonardo da Vinci, Notebooks

I liken her [that is, Fortune] to one of these violent rivers which, when they become enraged, flood the plains, ruin the trees and the buildings, lift earth from this part, drop in another; each person flees before them, everyone yields to their impetus without being able to hinder them in any regard. And although [rivers] are like this, it is not as if men, when times are quiet, could not provide for them . . .

—Niccolò Machiavelli, The Prince
Chapter 1

A MYSTERIOUS FRIENDSHIP

Leonardo da Vinci and Niccolò Machiavelli probably first met in the town of Imola during 1502. Their paths crossed at the court of Cesare Borgia, where—for different reasons—each was in residence from October through the end of the year. Leonardo had taken a position as Borgia’s military architect and engineer. Niccolò, second chancellor of the government of Florence, was on a diplomatic mission to keep an eye on the unscrupulous Cesare. By June of the next year, both were back in Florence, working together on what turned out to be a magnificent failure.

Few know about the mysterious and ill-fated collaboration between these two famous men. Leonardo da Vinci, creator of the Mona Lisa and the Last Supper, is one of the best-known artists in history. Niccolò Machiavelli, whose The Prince has been blamed for immorality and praised for introducing a science of politics, is one of our best-known political thinkers. In the first years of the sixteenth century, they conceived an ambitious project to direct the Arno River through a canal, at some points twenty miles away from its natural course.
A decade before, Leonardo da Vinci had first developed a plan to make the Arno River navigable, turning Florence into a seaport and irrigating the Arno valley. Niccolò Machiavelli, as an administrator responsible for Florentine military and foreign policy, tried to implement the first phase of this project in 1503–4 in order to divert the river from Pisa, deprive the city of water, and thereby win a war that had frustrated his fellow citizens for a decade. Had the diversion at Pisa succeeded, it was hoped to go ahead with Leonardo’s larger scheme of moving the Arno into a canal through Prato and under Mount Serravalle, transforming the economic basis of Florentine power.

Between 1503 and 1506, Niccolò Machiavelli benefited from Leonardo’s assistance on other projects in addition to this plan to divert the Arno. In June 1503, at Machiavelli’s insistence, Florentine troops besieging Pisa captured a fort called La Verruca; Leonardo was immediately sent as a military architect to propose its reconstruction. In fall of 1504, Machiavelli needed to show Florence’s good intentions to Jacopo IV d’Appiano, lord of Piombino; Leonardo was sent on a mission of technical assistance. Because previous attempts to storm the walls of Pisa had failed, Leonardo worked out a complex scheme for blowing up partial sections of the walls in a way that would reduce loss of life among the attacking forces.

For his part, Leonardo da Vinci benefited from Machiavelli’s position in the government. Lacking income on his return to Florence in 1503, Leonardo received the commission to paint an immense fresco—The Battle of Anghiari—in the Great Council Hall of the Palazzo Vecchio. To help plan the work, Machiavelli’s assistant Agostino Vespucci (cousin of the explorer Amerigo Vespucci) wrote a description of the battle scene, which has been found in Leonardo’s Notebooks. When progress on the painting did not satisfy the political leadership, Machiavelli played a role in negotiating a contract that allowed Leonardo to continue receiving his pay. On other matters as well, including Leonardo’s lawsuit over a disputed inheritance, Machiavelli and his assistant Agostino apparently were of assistance.

Most of the projects on which Leonardo and Machiavelli collaborated were failures. The ditches intended to divert the Arno at Pisa collapsed because of a combination of incompetence and bad luck. The project was abandoned amid recrimination and criticism of its cost, ending any hope of implementing Leonardo’s broader plan to make Florence a seaport. The following year, Leonardo had another disaster with his Council Hall fresco. The preliminary drawing for the Battle of Anghiari was the wonder of all who saw it. But because Leonardo used an experimental technique on the wall, paint ran and dripped, work on it was abandoned, and eventually the partially completed fresco was destroyed.

At the time, these setbacks had very serious implications for both Leonardo and Machiavelli, putting into question their reputation, status, and income. This probably explains why neither wrote of their work together. Who likes to bring attention to a disaster that can be attributed to bad judgment or incompetence? Today, however, the story is worth knowing. We see the human side of these two men of genius by appreciating how and why their collaboration failed.

In the five years after the attempt to move the Arno, Niccolò’s fortunes seemed to recover. He organized a popular militia that played an essential role in the defeat of Pisa in 1509, allowing Florence to regain control of the Arno as far as the Ligurian Sea. Three years later, however, Niccolò’s militia was routed by the Spanish. The republican government he served was overturned and Niccolò himself removed from office. Early in 1513 he was arrested and tortured on suspicion of plotting to kill Giuliano de’ Medici, even though Giuliano and Niccolò had been associated years before and Niccolò actively sought to work for the Medici. After over a decade of public service, Niccolò lost his powerful role in Florentine politics, suffering what he called “a great and continuous malignity of fortune.”

In the years after the Arno diversion failed, Leonardo also confronted frustration and loss of power. Abandoning his work in Florence, he moved to Milan in 1506. When his stepbrothers challenged an inheritance, he returned to pursue the legal case through interminable delays; ultimately, the conflict was settled by his agreement to leave disputed wealth to his
stepbrothers on his death. Although Leonardo achieved financial security and status while serving the French in Milan between 1508 and 1512, all this was lost when the French armies were defeated and retired from Italy. Leonardo then entered the patronage of Giuliano de’ Medici and moved to Rome, but life in the entourage of the Medici popes was not congenial. In the last years of his life, from 1516 to 1519, Leonardo finally found relatively secure wealth and status in Amboise at the court of Francis I of France, but by then a stroke had limited his artistic abilities.

The unsuccessful collaboration of Leonardo and Niccolò between 1503 and 1506 was ambitious and foresighted. Yet their attempt to move the Arno has been lost in the mists of history. Because their joint projects failed, little is known of their work together. Both men, often attacked by political enemies, had reason to remain silent about the disastrous Arno diversion. Other factors also conspired to hide their friendship.

Leonardo da Vinci and Niccolò Machiavelli were among the most secretive figures in our intellectual tradition. Between 1498 and 1512, Niccolò learned deception the hard way as a government official and diplomat often involved in delicate negotiations in dangerous places. Late in his life, he said of himself that “for some time now I have never said what I believe nor ever believed what I said; and if indeed I do sometimes tell the truth, I hide it behind so many lies that it is hard to find.”

Leonardo also had his reasons for secrecy. Among his works were many practical inventions he sought to keep to himself and scientific inquiries that contradicted orthodox Christian doctrine. Although we know many details of Leonardo’s life from his Notebooks, the entries are mainly jottings in mirror writing (from right to left) for his private use.

Because letters were often intercepted and read by one’s enemies, a written message often had to protect its author and recipient through indirection, silence, and subterfuge. Niccolò Machiavelli, as a powerful public servant, was frequently at the center of situations that called for diplomacy and discretion. Leonardo da Vinci, serving as artist, engineer, and advisor to rulers and governments, found himself in similar circumstances. During the Renaissance, it could be dangerous to put everything in writing. As Niccolò’s friend Francesco Vettori put it, “I wish I could write many things that I know cannot be entrusted to letters.”

What was true of correspondence at the time was true of behavior more generally. Charges of religious heresy or political disloyalty could be a matter of life and death. Assassination of enemies was not infrequent. In 1478 Giuliano di Piero de’ Medici—brother of Lorenzo the Magnificent—was murdered in a conspiracy led by one of the city’s leading aristocratic families. A generation later, Savonarola, the reformist preacher who effectively ruled Florence for four years, was excommunicated after openly challenging the pope, and then arrested, convicted, and burned at the stake outside the Palazzo Vecchio.

Another factor was a Florentine law that allowed anonymous accusations. At different times in their careers, both Leonardo and Niccolò were subject to such accusations: Leonardo in 1476 on a charge of sodomy (legally punishable by death), Niccolò in 1509, when political enemies claimed he was not legally eligible to serve as second chancellor and should be forced to resign. As Niccolò’s assistant wrote him after the accusation of 1509, “your adversaries are numerous and will stop at nothing. The case is public everywhere, even in the whorehouses.” For both Leonardo and Niccolò, the possibility of such challenges remained a constant threat to status and political influence.

To understand the story of these two men, therefore, we have to look behind the usual textbook accounts. Documents exist that reveal private attitudes and remind us that famous men and women of the Renaissance were human beings with familiar passions and foibles. In the letter from Francesco Vettori quoted above, after lamenting the inability to write everything, Niccolò’s correspondent explains why he has fallen in love.

Vettori, serving as the Florentine ambassador to the pope, has little to do:

I wrote you that idleness made me fall in love and I reaffirm this to you, because I have practically nothing to do. I cannot read much, by reason of my eyesight, which has been diminished by age. I cannot go out and enjoy myself unless I am accompanied, and this cannot always be done:
I do not have so much authority or such resources as to be sought out; if I spend my time in thought, most of them bring me melancholy, which I try my best to flee; of necessity one must endeavor to think of pleasant things, but I know of nothing that gives more delight to think about and to do than fucking. Every man may philosophize all he wants, but this is the utter truth, which many people understand this way but few will say.

Whatever the historical changes over the last five centuries, the protagonists in our story remain very much our contemporaries.

Leonardo and Niccolò were fascinating, amusing, talented men, sometimes tortured by despair and often surrounded by enemies. Both had ideas ahead of their times—and knew it. Both attracted admiring friends, exercised power—and ultimately failed to succeed in some of their most cherished projects. Both could be charming—or exasperating. And at times, both had unbelievably bad luck.

This is the story of two men and a river. Although the two men are well known, the river, beautiful and rich in history, has a role of its own. Rivers are means of transportation and energy, sources of water for crops as well as people—and when they flood, devastating in their destruction. The Arno was all of these. It also provided the principal reason Leonardo da Vinci and Niccolò Machiavelli worked together. The failure of their grandiose plans—and of the other projects they attempted—teaches a great deal about Leonardo, Niccolò, and an extraordinary moment in Western history.

Chapter 2

The Arno

The Arno River originates in a multitude of streams along the western slope of the Apennines, the mountains that form the backbone of the Italian peninsula. It forms a long loop to the south toward Arezzo before flowing westward, to be joined by the Sieve River. After a few miles, the river flows through Florence. Then it is joined by other confluent streams like the Ombrone, which runs southward past the town of Vinci before meeting the Arno about twenty miles below Florence. From that point, the river winds between steep hills before reaching the plains at Pisa and flowing on to the Ligurian Sea (Figure 2.1).

The valley watered by the Arno contains rich agricultural lands, forming the core of the region known as Tuscany, of which Florence is the economic and political capital. The river is the lifeblood of this region, but at times it is dangerous. Throughout the fourteenth and fifteenth centuries, the Arno was capricious: in 1333, 1466, and 1478, serious floods destroyed crops and damaged buildings in the towns along its banks. Despite these disasters, however, the valley and the hill towns overlooking it flourished.

By 1450, Florence had emerged as one of the major centers of the
that rivers hold the foremost place on account of their excessive and violent inundations. . . . Against the irreparable inundation caused by swollen and proud rivers no resource of human foresight can avail; for in a succession of raging and seething waves gnawing and tearing away high banks, growing turbid with the earth from ploughed fields, destroying the houses therein and uprooting the tall trees, it carries these as its prey down to the sea which is its lair, bearing along with it men, trees, animals, houses, and lands, sweeping away every dike and every kind of barrier, bearing along the light things, and devastating and destroying those of weight, creating big landslips out of small fissures, filling up with floods the low valleys, and rushing headlong with destructive and inexorable mass of waters.

For Christian believers in the sixteenth century, floods were an act of God. In contrast, Leonardo sought ways to give humans control over them.

After moving to Milan in the 1480s, Leonardo began to study the flow of water as a scientific problem in order to prevent floods, irrigate fields, and develop river transportation. To use hydraulic science effectively, he realized that technological expertise was needed because

_a river which is to be turned from one place to another must be coaxed and not treated roughly or with violence; and to do this a sort of dam should_

Leonardo da Vinci probably knew the course of the Arno as well as any individual who had ever lived. In many places, the Arno winds among the Tuscan hills with memorable beauty. Leonardo captured one such site in his earliest known drawing, dated August 5, 1473 (Plate II).

Leonardo knew, however, that the river was not always tranquil.
be built into the river, and then lower down another one projecting farther and in like manner a third, fourth, and fifth so that the river may discharge itself into the channel allotted to it, or by this means it may be diverted from the place it has damaged as was done in Flanders according to what I was told by Niccolò di Fortore.

While in Milan, Leonardo apparently met Luca Fancelli, a Florentine architect, who proposed a system of canals to make the Arno navigable and improve the valley. Employing his knowledge of hydraulics, Leonardo worked out a more ambitious plan, with a single long canal through Pistoia. For such a project, he needed to know the precise location of the river's course. One of his remarkable maps, which he based on the work of earlier cartographers, shows the entire valley (Figure 2.1). This map, amazing for its accuracy, probably dates from 1502–3, when Leonardo was authorized to travel through the area as Cesare Borgia's military architect and engineer.

Like Leonardo, Machiavelli was interested in rivers more generally as well as the particular problems associated with the Arno. Readers of The Prince are familiar with a famous passage in Chapter 25 that compares "fortune" (or human history) with a river:

> I liken her [that is, Fortune] to one of these violent rivers which, when they become enraged, flood the plains, ruin the trees and the buildings, lift earth from this part, drop in another; each person flees before them, everyone yields to their impetus without being able to hinder them in any regard.

Most scholars assume this is merely a poetic metaphor. Now, however, we know it also reflects Niccolò's practical experience in the attempt to divert the Arno at Pisa during 1503–4.

In The Prince, immediately after the passage cited above, Machiavelli echoes Leonardo's practical concern for controlling the flow of rivers:

> And although they [rivers] are like this, it is not as if men, when times are quiet, could not provide for them with dikes and dams so that when

they rise later, either they go by a canal or their impetus is neither so wanton nor so damaging.

For Machiavelli, however, the "rivers" are history, the "trees and the buildings" are civilization, and the "dikes and dams" are "good laws and good arms," which can be established only by outstanding leaders. While Leonardo focused on improved technological projects to control actual rivers, Machiavelli drew a political lesson from the failure of the Arno diversion.

Human efforts to control rivers were, of course, hardly new. In ancient times, the Tigris and Euphrates in Mesopotamia, the Nile in Egypt, and the Yangtze in China had been tamed to control floods and irrigate crops, just as Roman cities had been supplied with water through immense systems of aqueducts. Since the twelfth century, especially in Lombardy, Italian rivers had been harnessed by a system of dikes and canals, much as the Dutch had controlled the flooding from the North Sea with similar techniques.

Even military uses of artificially controlling rivers were not unknown. In the Divine Comedy, Dante, who also speaks of the peaceful uses of hydraulic engineering, imagined a way to punish Pisa by moving two islands so they would dam the Arno and flood the city. Early in the fifteenth century, the architect Brunelleschi convinced the Florentine government to try this device in practice, unsuccessfully damming the nearby Serchio River to flood Lucca. But nothing in earlier experience can compare to the grandiose project of making Florence a seaport by moving the winding Arno into a canal through Pistoia (which is over twenty kilometers north of the river's natural course) and tunneling it under the mountain pass of Serravalle on the way to the sea. Beyond the competence of sixteenth-century technology, such vast transformations of nature have become commonplace only in our own time.

The history of public works that control rivers is thus a good summary of the process of civilization. Reliable supplies of water are essential for both agriculture and urbanization. Before the Neolithic revolution,
humans formed relatively small bands of hunter-gatherer-scavengers, which traveled as game moved, water holes dried up, or floods came. With the domestication of animals and the discovery of agriculture came sedentary villages and larger tribes, but these developments were not enough to make possible cities and civilizations.

Even with agricultural settlements along rivers, food supplies were not certain. Too little water, and crops fail; too much water, and floods destroy everything. In good years, many rivers—including the Arno—flood just enough to enrich agricultural soil. Usually, however, it was risky to rely entirely on nature. The centers of early civilizations were usually cities along rivers, and those civilizations were typically marked by massive hydraulic projects that made possible the irrigation of fields as well as the transport of heavy goods and the control of floods.

Several examples from the Roman province of Gaul, still visible in southern France today, illustrate the extraordinary technology associated with controlling rivers and water in ancient civilizations. Well known as tourist monuments, these examples also remind us how completely Roman hydraulic engineering had been lost during the early Middle Ages.

Roman bridges across the Rhône River are a good example. Rivers can divide land or unite it, depending on the ability of the inhabitants to cross them as well as to use them as waterways. The Rhône, as a major artery, could easily be used to float objects from the center of Gaul to the Mediterranean. But for the purposes of trade, it was also sometimes necessary to cross easily from one bank to the other. The Romans solved this problem with bridges of considerable size, spanning the Rhône at Vienne and at Arles.

According to some, the memory of yet another Roman bridge is implied in the old children’s song “Sur le Pont d’Avignon, on y danse, on y danse.” Actually, the song is about dancing under the medieval bridge at Avignon (originally, the words were “Sous le Pont d’Avignon”). There was an island in the middle of the Rhône that partially supported the bridge linking the papal city of Avignon with the territories of the French king. Because the island was neutral territory, dancing was possible there while not permitted on the shore. But the story of the bridge itself is even more interesting than the dancing.

In the Middle Ages, the Rhône at Avignon had been impassable except by boat. In the twelfth century, a peasant claimed that God told him how to build a bridge across the river. At first, everyone thought the task impossible: medieval stonemasons knew of no way to sink the foundations for a bridge in a river of such size and power. According to one account, the peasant’s solution was actually simple: he built the bridge on the ancient pilings of a Roman wooden bridge, long since destroyed and forgotten. Divine revelation had probably been assisted by underwater swimming.

In classical antiquity, extraordinary engineering skill was evident also in the provision of water to Rome and the cities it controlled. Rome’s Acqua Claudia aqueduct—built in the fourth century B.C. and restored by Pope Sixtus V—still functions today. It is in the Roman province of Gaul, however, that ancient remains probably give the clearest indication of the extent of Roman hydraulic engineering.

The Roman city of Arele—today the French city of Arles—stands at a sharp bend of the Rhône River. Its water supply came by aqueduct from many miles away. One segment of the system of water supplies still remains: the magnificent Pont du Gard. Because Arele developed on both sides of the Rhône, lead pipes were necessary to bring water from the central part of the city to Trinquetaille, on the other bank. Within the old city of Arles itself, one can visit the Roman baths, which provided public facilities for both hygiene and pleasure. Even in this provincial city, Roman technology tamed and utilized water to make living conditions comfortable and “civilized.”

By the third century A.D., the system of aqueducts serving Arele was expanded to bring water to the first automated factory known in history—a mill with twenty water-powered millstones for grinding the wheat of Gaul prior to its shipment to Rome, where it became the bread accompanying the circuses. The site, known as Barbegal, can be visited today just outside of Arles. In Roman times, it was surrounded by marshes, which allowed the delivery of grain floated down the Rhône and, after milling,
its shipment to storage granaries in Arles and ultimately, by boat, to the Roman port of Ostia.

Today, tourists in Provence often visit the Pont du Gard or the Roman baths in Arles—and if well informed, even picnic on the steps of Barbegal. But only in the last two hundred years has industrial technology become fully capable of feats that the Roman engineers accomplished throughout the Empire.

Although many early villages were formed on fortified hills for security, since antiquity large cities have usually developed at the confluence of trade routes. Such cities played a central role in Italy throughout the fifteenth century. Milan was a crossroads of land routes in the Lombardy plain. Naples, Venice, and Genoa were major seaports. And like Rome, Florence was a city on a river. Its site on the Arno helps explain the role of the city and its region throughout history.

In *Florentine Histories*, published in 1525, Machiavelli explained the origins of his native city:

> since the city of Fiesole had been placed on the summit of a mountain, to make its markets more frequented and more convenient for those who might want to come to them with their merchandise it had ordered the place for them not on the hillside but in the plain between the foot of the mountain and the Arno River. . . . Afterwards, when the Romans had conquered the Carthaginians, rendering Italy safe from foreign wars, the buildings multiplied to a great number . . . thus the security that was born in Italy through the reputation of the Roman Republic enabled the dwellings, already begun in the mode stated, to increase to such number that they took on the form of a town, which from the beginning was named Villa Armina.

Before becoming the city we know as Florence, then, the site even took its name from the river. With the civil wars that ravaged ancient Rome in the first century B.C., Florence grew into a genuine city, called Florentia, whose inhabitants were known as Florentini.

The Roman Empire brought with its rule the skill of its engineers. In Roman cities, life was made comfortable by plentiful public water supplies using aqueducts and lead pipes; there were toilets with sewers, and public baths. Water was used for transport and as a source of mechanical power. The control of water supplies required for such civilized amenities depended upon governmental decisions, as Machiavelli noted when citing the Roman historian Tacitus:

> For already in the time of Tiberius they [the people of Florence] governed themselves by the custom of the other Italian cities, and Cornelius [Tacitus] refers to Florentine spokesmen as having come to the emperor to beg that water from the [Val di] Chiana not be emptied onto their country.

With the establishment of Constantinople and the fall of the western empire, waves of barbarians from the north descended on Italy. Technological know-how was lost in the ensuing centuries of chaos, but eventually the engineers of the Renaissance improved their ability to tame rivers. Some of the first developments were aided by accidents. The Belgian city of Bruges rose to prominence in the twelfth century after a flood opened the six-mile stretch of the Zwyn River to the North Sea (though the city declined in power three centuries later after silting again blocked the channel). Seeking to control these events, hydraulic engineers in the late thirteenth century developed techniques to prevent floods, keep harbors open, and use water. In Italy, rivers that had long been clogged by silt began to be improved. Engineers started to think of draining marshes and building canals, of using waterways again as a mode of transport and a source of energy. Better ships were built, most notably in Venice, where the technology used in the shipyards of the Arsenale was such a highly guarded secret that an unapproved visitor would be put to death.

The historical development of Florence would always be intimately
incorporated with the river from which it first took its name. After the
floods of 1333, there was much discussion of the problems of controlling
the Arno. As early as 1347, the government of Florence considered the
project of making the river navigable to the Ligurian Sea. In the Po valley
and Lombardy, the building of dams and canals was even more advanced.
Whereas the annual flooding of the Arno in good years provided natural
irrigation, the drier plains to the north were not as fertile. Around Milan,
a network of canals was developed from the twelfth century onward, link-
ing the lake region around Como to the north with the Adda, Lambro, and
Brembo Rivers. Milan’s prosperity at the center of the Lombard plain
depended in no small part on the irrigated fields and water-powered mills
made possible by progress in hydraulic engineering.

The rediscovery of engineering and the development of trade provided
an important foundation for art and philosophy. After a long period of insta-
bility between 1180 and 1350—associated with rapid population growth,
persistent inflation, famine, plagues, and warfare—scholars have described
the period from around 1400 to 1470 as the “equilibrium of the Renaissance.”
Particularly in Italy, agriculture flourished and harvests improved, popula-
tions stabilized, and political conflict moderated. These transformations
were slower to come to northern Europe, particularly in regions where the
technology of water control was not as well developed as in Italy.

Commerce developed along with banking houses (like that of the
Medici of Florence), which helped make it possible. Technology spread
more rapidly than ever before. A striking example is provided by printing.
Schoolchildren know that Gutenberg invented movable type and used it to
print the Bible in the middle of the fifteenth century. Within a decade,
Gutenberg’s invention was in use in Strassburg and Basle; within twenty-
five years, it had spread throughout Italy and to France, Poland, England,
and central Europe. Similar changes took place in military technology, as
gunpowder and cannon were developed and used in Europe for the first
time to destroy medieval fortresses.

Political institutions in Italy favored such technological and economic
development. With no single ruler in command of the entire peninsula,
different cities were open to entrepreneurship and rivalry, sometimes

without the constraints of feudal lords (who frequently taxed and restrict-
ed commerce for short-term benefits). The relative social mobility and
openness of the Italian cities, like those of Greece in antiquity, fostered a
spirit of enquiry and innovation. These trends were particularly evident in
Florence, a republic governed by elected assemblies and officials quite
unlike the hereditary kings of France, Spain, England, or Germany. As the
great humanist Leonardo Bruni wrote in 1428, “equal liberty exists for all—
the hope of gaining high office and to rise is the same for all.”
Though he exaggerated a bit, the city on the Arno did achieve a measure
of republican self-government.

Major decisions in Renaissance Florence were made by an executive
committee called the Signoria. Two members of the Signoria were chosen
from each of the four quarters into which the city was divided, with the
ninth being the head of government, or standard-bearer of justice (gon-
faloniere), representing the city as a whole. The eight members of the
Signoria representing quarters of the city (called priors) were elected by
lot; names were pulled from a bag containing the names of eligible male citi-
zens who had paid their taxes. Their term of office lasted only two months.

Decisions of the Signoria were also referred to two councils, the
Twelve Good Men (Buonomini) and the Sixteen Standard-bearers
(Gonfalonieri), representing the four flag companies in each quarter. Also
elected by lot, these officers served for three or four months. Specialized
committees, like the Ten of War (Dieci), responsible for military affairs,
were also appointed. Finally, before making an important decision, the
Signoria often convoked a special consultative meeting (practica) of citi-
zens to discuss alternatives in public.

Under Lorenzo the Magnificent, who controlled the city from 1476 to
1492, the system was manipulated by putting only Medici supporters’
names in the bags from which officials’ names were drawn. After
Savonarola became the effective leader of Florence in 1494, the popular
element underlying the city’s institutions was strengthened. To prevent the
abuses of the Medici, a Great Council was formed, based on lists from all
citizens whose parents or grandparents had been eligible for office. This
body elected the Signoria and the colleges of the Twelve Good Men and the
Sixteen Standard-bearers by picking names from a leather bag into which all eligible names were placed. Other positions were filled by a Council of Eighty on the basis of nominations made and seconded in the Great Council. Among these elective officials were administrators: the chancellors and secretaries, like Niccolò Machiavelli, who served the Signoria and other government committees.

On paper this sounds very democratic, but the reality was quite different. First of all, not everyone could vote. The total population of Florence in the fifteenth century has been estimated as between forty and ninety thousand. Of these, only taxpaying resident male citizens over thirty could vote. Of the roughly eight thousand men of age, only around fifty-six hundred had the taxable wealth required to be on the voting rolls. The actual electorate was further restricted by the need to be a member of a guild, to have actually paid taxes, and to be in Florence at the time of the vote.

Second, political practice was a matter of patronage, cliques ("sects"), and personal alliances rather than individual voting. Wealthy or aristocratic families formed the core of the system. The leaders of a family provided favors for friends and neighbors in return for support. In the words of one historian, Florentine politics resembled "a league of Mafia families."

Personal connections were based also on confraternities. Originally associated with religious activity and based in churches, some of these associations came to link leading aristocrats and voters of specific quarters or in specific trades. In the middle of the fifteenth century, these adult confraternities were supplemented by youth groups, often associated with a family of wealth and preeminence in a particular quarter. For example, both the Vangelista youth confraternity (named for Saint John the Evangelist) and the adult Confraternity of Saint Paul were based in Niccolò's parish church of Santa Trinità, and both were supported by Lorenzo de' Medici, whose son Giuliano was a member of Vangelista until he reached the age of twenty-four (when young men were supposed to leave the youth groups). Although some confraternities stressed religious devotion, with rituals of flagellation and prayer, others focused on assisting the poor or running hospitals, while providing a network of social contacts (not entirely unlike Rotary, Kiwanis, or other American service clubs today).

While far from perfectly democratic, Florence still provided a highly diverse environment in which economic initiative, artistic ability, humanistic scholarship, and political astuteness could flourish. Artists—and artists—took renewed interest in novelty. A few, like the architect Brunelleschi, began to study natural science and applied themselves to such technological questions as flood control along the Arno. More often, change took the form of an increased willingness to experiment. Travel, whether by land or water, became easier. Innovation was applied to military strategy as well.

Praising his native city, Leonardo Bruni claimed that "Florence harbours the greatest minds: whatever they undertake, they easily surpass all other men, whether they apply themselves to military or political affairs, to study or philosophy, or to merchandise." In Florence as elsewhere, however, there was still a profound gap between the scientists and humanists, who studied theory, and the artisans and technicians, who made things work. In philosophy and science, the Renaissance of ancient pagan thought was the work of scholars who were far removed from technology and practice. Although the humanists sometimes played a role in politics, they came from a different world than the first generations of inventors and engineers whose practical know-how fueled the economic developments of the thirteenth and fourteenth centuries.

Pico della Mirandola expressed the spirit of many fifteenth-century humanists in his Oration on the Dignity of Man. In a revealing point in the work, God admonishes Adam:

You may have and possess whatever abode, form and functions that you might desire. The nature of all other beings is limited and constrained within the bounds of law prescribed by us. But you, constrained by no limits, in accordance with your own free will, in whose hand we have placed you, shall ordain for yourself the limits of your nature.

This stirring manifesto, far removed from practical technology or natural science, broke with medieval traditionalism without embracing either empirical research or political activism.
In Florence as elsewhere in Italy, the doctrines of the Catholic Church were still generally honored, but popes increasingly acted as secular rulers, competing with kings, dukes, and republics for political power and earthly prestige. Despite the pragmatism of fifteenth-century engineers, artisans, bankers, or political leaders, Renaissance humanists were often more concerned with astrology than with natural science. And through it all, the life of the common man was often little different than it had been hundreds of years before.

Leonardo da Vinci and Niccolò Machiavelli grew up and worked together in this exciting world along the Arno. In some ways, however, these two men were different from those around them. Leonardo was angered by the humanists of Florence, who disdained him because he did not speak Latin and his scientific theories were based on experimentation and mathematics rather than quotations from the ancient authors. Machiavelli, taught by those humanists, came to view their thought as contrary to the lessons of classical antiquity and an obstacle to the beneficial exercise of political authority. Both sought to develop theories of nature and human nature that could be used in practice to benefit society.

Leonardo created a science of hydraulics and imagined a comprehensive transformation of the Arno River valley into an irrigated flood-control system generating wealth and security for Florence and all of Tuscany. Niccolò, as a public servant, found himself responsible for gaining control of the rebellious city of Pisa, which blocked the free use of the Arno for Florentine commerce. To this end, Niccolò supervised an attempted diversion of the river, intended both to defeat the Pisans by depriving them of water and to realize the first stage of Leonardo’s larger scheme.

To many of their contemporaries, even the diversion at Pisa (the initial phase of this project) was a foolish waste of time and money. The first time the government debated the proposal, some criticized it as “little more than a fantasy.” Both the Florentine field commander and the commissioner in charge of the siege of Pisa tried vigorously to stop it. Two years after the project failed, the field commander wrote Machiavelli: “Certainly, as far as human judgment can see, we cannot hope for anything but ill, if He that saved the people of Israel from the hands of Pharaoh does not open up for us in the midst of this tossing sea an unexpected road to salvation, as that one once was.” For most people in the early sixteenth century, only God could part the Red Sea or manipulate the Arno for human benefit.

Leonardo and Machiavelli tried, through scientific engineering, to do what God did for Moses. Despite their failure, the ideas behind the project were to have a lasting impact. Leonardo developed, in outline, scientific theories and technical inventions that were not fully realized for three centuries. Niccolò presented a theory of politics that ushered in modern nation-states and taught leaders a new attitude toward action. Working together in Florence between 1503 and 1506, the two sought to turn knowledge into power. But to understand why they were attracted to each other, it is necessary to describe how Leonardo da Vinci and Niccolò Machiavelli came to be in Imola in October 1502.
Chapter 3

Leonardo Achieves Fame

(1452-1499)

Vinci, a small hill town in Tuscany above one of the Arno’s tributaries, gave its name to a family of lawyers and thrifty landowners—and thus a world-famous artist. In the middle of the fifteenth century, Ser Piero da Vinci, local notary and twenty-three-year-old son of this well-established family, had an affair with Caterina, a peasant girl. When Caterina became pregnant, a wedding was out of the question: though an illegitimate child was no longer a permanent disgrace, her class and lack of dowry were an insuperable barrier to marriage. And so, not long after Leonardo da Vinci, the child of Caterina and Ser Piero, was born on April 15, 1452, Piero da Vinci was married to Albiera di Giovanni Amadori, a sixteen-year-old from a more appropriate family.

Leonardo was at first sent to live with his mother, Caterina, who had been conveniently betrothed to a young farmer from the nearby hamlet of Campo Zeppi. Albiera remained childless, however, and by 1457, tax records show that Leonardo was living in his father’s house in Vinci. Ser Piero often went to Florence, where business interests led to his partnership with a local notary in an office across the street from the Bargello (the
famous prison in the center of the city). After his wife, Albiera, died, Ser Piero married Francesca Lanfredini in 1465, choosing a wife from one of the most prominent commercial families in Florence. Meanwhile, Leonardo was raised in Vinci by his paternal grandparents and their youngest son, Francesco, only sixteen years Leonardo’s senior.

Sometime before 1468, in his teens, Leonardo moved to Florence, where he was apprenticed to Verrocchio, well known as a painter, sculptor, and goldsmith. Under Verrocchio’s tutelege, he learned many skills. In 1472, at the age of twenty, Leonardo was enrolled as a member of the painters’ guild. But Leonardo was not to be just an artist.

Leonardo’s extraordinary skills were soon apparent. The architect and art historian Giorgio Vasari, in his influential Lives of the Artists, called him “specially endowed by the hand of God,” the universal—or, as we now say, Renaissance—man, who could apparently do everything well. In virtually every field, from physics, anatomy, and engineering to music, architecture, and city planning, Leonardo was an innovator whose ideas, spread by word of mouth and example in an age when printing was still something of a rarity, foreshadowed and influenced developments in coming centuries.

Genius often seems to spring up in a miraculous way, without regard to circumstances. For Leonardo, however, the circumstances of birth did have at least one lasting effect. Had he been the legitimate heir of Ser Piero growing up in Florence, he would more likely have gone to school, learned Latin, and become a humanist. As it was, Leonardo was not accepted by the humanistic scholars at the university and the Platonic Academy in Florence. This rejection galled Leonardo so intensely that, as a man over forty, he learned Latin and spent hours recording vocabulary-building exercises in his Notebooks.

Painters and artisans—often one individual was both—usually came from a different social class than scholars, or humanists. For example, the father of Marsilio Ficino, perhaps the most famous philosopher in Florence, was a doctor; Angelo Poliziano, another leading classicist associated with the Medici court, came from a family of jurists. By contrast, Perugino—Leonardo’s fellow apprentice in Verrocchio’s studio—came from a peasant background. For such artists, a living wage was often more important than formal status. Not so for Leonardo, whose manner, dress, and aspirations were those of his father’s class rather than of his contemporaries in the world of art.

Leonardo’s frustration at the rejection of his work by humanist scholars is epitomized by a draft Introduction for his Treatise on Painting:

I am fully conscious that, not being a literary man, certain presumptuous persons will think that they may reasonably blame me; alleging that I am not a man of letters. Foolish folks! do they not know that I might resort as Marius did to the Roman Patricians by saying: That they, who deck themselves out in the labours of others will not allow me my own. They will say that I, having no literary skill, cannot properly express that which I desire to treat of; but they do not know that my subjects are to be dealt with by experience rather than by words; and [experience] has been the mistress of those who wrote well. And so, as mistress, I will cite her in all cases.

Most Renaissance artists established a studio, taught apprentices (who often had to pay for the right to work), and undertook commissions for artisanal products. Verrocchio’s bottega produced the enormous bronze ball to mount on the cupola of Florence’s Duomo, costumes and decorations for Lorenzo de’ Medici’s pageants, and a suit of armor for presentation to the duke of Milan, as well as statues and paintings for Florence’s churches, guilds, and wealthy patrons. Leonardo could contribute to making all these things with amazing skill, but he also sought to discover and teach the fundamental principles underlying them. To explain the art of painting, for instance, he engaged in experimental and observational studies of vision, an analysis of optics, and—to ensure that the dynamics of bodily movement was accurately portrayed—anatomical studies of humans as well as other animals.

Perhaps as a result of his father’s social class, Leonardo brought an intellectual or scientific approach to activities that were often based on tradition, individual hunches, imitation, and trade secrets. In personal terms, Leonardo also sought a degree of public recognition that was long denied
him. Not only did his ambition transcend the horizon of most painters; he also sought greater political and social influence than most of the humanists and scientists.

Leonardo developed from the illegitimate son of a notary into *l'uomo universale* in three main stages. The first was in Vinci from 1452 to around 1467, where as a child he discovered his artistic skill. During the second, working with Verrocchio in Florence between 1467 and 1482, Leonardo explored the diverse and remarkably free life of that city and realized that his genius transcended art. In the last stage, after moving to Milan, from 1483 to 1499 Leonardo further trained his many talents, working at first in partnership with the de Predis brothers (competent but not outstanding artists) and then as a member of Duke Ludovico Sforza's court. When Milan fell to the French in 1499, Leonardo was famous not only as an artist but as an engineer, scientist, architect, and musician.

We know little of the childhood of most famous men. Although Leonardo is unusual in the amount of information on his life embedded in his voluminous *Notebooks*, many of the entries are elliptical, private jottings for his own memory and pleasure. Still, the combination of this treasure with other written sources gives us a good idea of Leonardo's youth.

Because the rules of his father's guild did not allow an illegitimate son to become a magistrate or notary, Leonardo did not learn to read and write at a formal school. Perhaps this explains why, when he did acquire these basic skills, Leonardo—being left-handed—developed a practice of noting personal information in mirror script, written from right to left. Educated in Vinci, he never studied Latin and the classic authors in the fashion of the middle-class children of Florence.

With his father in Florence, the young Leonardo had time to wander alone in the hills around Vinci. As an inquisitive child, he discovered nature. Blessed with both a retentive memory and artistic ability, he was free to observe and to wonder.

Leonardo's *Notebooks* contain several passages that probably reflect these early experiences. One concerns a storm, which Leonardo describes in the draft of a chapter entitled "Of the Movement of Air Enclosed in Water":

*I have seen motions of the air so furious that they have carried, mixed up in their course, the largest trees of the forest and whole roofs of great palaces, and I have seen the same fury bore a hole with a whirling movement digging out a gravel pit, and carrying gravel, sand and water more than half a mile through the air."

In the *Florentine Histories*, Machiavelli describes such a storm, on August 24, 1456, in the Val d'Arno—and since there are no records of such a twister in Florence itself, it is possible the passage records a childhood memory that Leonardo shared with Niccolò.

A second passage describes an equally intense experience, though this time with a focus on Leonardo's own emotions as an observer of nature.

*Unable to resist my eager desire and wanting to see the various and strange shapes made by formative nature and having wandered some distance among gloomy rocks, I came to the entrance of a great cavern, in front of which I stood some time, astonished and unaware of such a thing. Bending my back and then my head, I stood, rested my left hand on my knee and held my right hand over my downcast and contracted eye brows: often bending first one way and then the other, to see whether I could discover anything inside, and this being forbidden by the deep darkness within, and after having remained there some time, two contrary emotions arose in me, fear and desire—fear of the threatening dark cavern, desire to see whether there were any marvellous thing within it.*

That eager desire to see and understand any marvellous thing in nature would never leave him.

Leonardo had an uncanny ability to remember visual images. At some point, he must have begun to draw. Ser Piero, looking for a place for his illegitimate son, obviously noticed his skill. As a notary and businessman in Florence, moreover, Ser Piero had contacts with the world of artists and
artisans. In 1465, Ser Piero signed the contract for an important commission with Verrocchio. Shortly thereafter, Leonardo became his apprentice in Florence.

The bottega, or workshop, of Andrea Verrocchio was, in many respects, a microcosm of the artistic and artisanal world of the Italian Renaissance. At various times, among his apprentices were Perugino, Botticelli, Ghirlandaio, and Lorenzo di Credi. Verrocchio’s assistants worked on the varied commissions he received from churches, merchant guilds, and the Medici. Together, they formed the nucleus of a generation of artists whose work is now taught in every introductory course in art history.

In this environment, Leonardo soon realized he surpassed others in artistic talent. Vasari describes an event that must have been a lesson in how much his skill could be worth. Ser Piero had been asked by one of his tenants to have a wooden shield decorated by a painter, and gave the job to his son, Leonardo. The young artist collected “lizards great and small, crickets, snakes, grasshoppers, bats, and other strange creatures,” dissected and combined them, and painted a monster “emerging from a cleft in a dark rock, vomiting fire from its gaping jaws, its eyes blazing, and poisonous vapors emanating from its nostrils.” When Ser Piero came to get the finished shield, Leonardo had set it in a darkened room, with only a ray of light from the partly closed shutters illuminating his creation. On seeing his father’s reaction of shock and fear, Leonardo opened the shutters to reveal his artistry, adding: “That is what a shield ought to do. Take it.” Ser Piero was so impressed that he bought an ordinary substitute for the tenant and sold his son’s work to an art collector for one hundred ducats. The shield in turn was sold to the duke of Milan for three hundred ducats.

Around 1472, when Leonardo formally registered in the painters’ guild, he assisted his mentor, Verrocchio, on a Baptism of Christ commissioned by the Monastery of San Salvi. Art historians are generally agreed that the angel at the lower left of this painting (and much of the background) is the earliest known painting by Leonardo. According to Vasari’s biography, Leonardo’s skill in painting the angel so astonished and dumbfounded his master that Verrocchio swore never to paint for the rest of his life.

Vasari’s story is probably an exaggeration, but three things are beyond doubt. First, Leonardo quickly gained a reputation for unusual artistic skill; second, he was clearly aware of his own abilities; finally, in addition to the friendship and confidence of Verrocchio, he began to encounter not only painters but the poets, writers, and scholars who made up the lively intellectual world of Florence in the 1470s.

Enjoying the company of others, Leonardo at this time engaged in a good deal of frivolity. From contemporary accounts and self-portraits, he was a young man of astonishing beauty. His musical talent and fine voice attracted note. His pleasure in practical jokes amused his fellows. According to one of his biographers, Leonardo’s main occupations were probably “dressing up, taming horses, and learning the lute.”

Being extremely attractive can have disadvantages. In 1476, a personal disaster struck. Under the Florentine system of anonymous denunciation, one could accuse another of illegal or immoral behavior by putting the charge on an unsigned paper in boxes set up for the purpose. This was not unlike Victorian England’s practice of placing anonymous items in newspapers to spread rumors of scandal. In Leonardo’s case, the consequences were frightening. Along with three others, he was accused of committing sodomy on a known prostitute. The penalty, though rarely carried out, was death at the stake.

A first hearing, on April 9, 1476, produced no evidence. The case was adjourned, and a second hearing held on June 7. No evidence was forthcoming and the charges were dismissed. Some have suggested that the real target was another of the accused, Lionardo de’ Tornabuoni (a relative of Lorenzo de’ Medici’s mother), that the entire affair was politically motivated, and that Leonardo was included merely to “augment the lineup.”

Whatever the truth of the charges, Leonardo was apparently terrified by the threat to his precarious status. Biographers suggest the charge contributed to his obscure but complex attitude toward sexuality. Some think that Leonardo was repelled from all forms of sexuality, while others deduce from Leonardo’s attraction to handsome young men that he was homosexual. At least one conclusion is generally accepted: “There is no record of any woman in his life—not even a female friendship.”
During the years following this public accusation, Leonardo more fully revealed his artistic skill. From this period can be dated the portrait of Genevra de’ Benci (now in the National Gallery in Washington—the only painting by Leonardo in an American museum); the *Benois Madonna* (now in the Hermitage, St. Petersburg); and the haunting but unfinished *Saint Jerome* (now in the Vatican). Each of these paintings reveals elements of precision, of daring novelty, and of powerful emotion rarely attempted prior to Leonardo.

Leonardo also began to explore technological inventions and scientific inquiries of a remarkable variety. To be sure, there were other artists (like Brunelleschi) interested in a scientific approach to perspective or anatomy. Leonardo, however, extended his inquisitive search for knowledge and technical skill further, and in more varied directions, than anyone at the time.

Unlike most artists, he sought out scientists and university professors. As early as the 1470s, Leonardo may have attended lectures on Aristotle’s natural philosophy by John Argyropoulos, a Greek scholar who taught temporarily in Florence. After 1480, Leonardo apparently made the acquaintance of other scholars, including Benedetto Aritmetico (a specialist in engineering and mechanics) and Paolo del Pozzo Toscanelli (the astronomer whose map of a westward route to India was to guide Columbus in 1492). Among Toscanelli’s maps of the world was one (made in 1474) in the shape of a globe; among Leonardo’s notes are references to “a globe” and to “my map of the world which Giovanni Benci has.”

While studying with Toscanelli, Leonardo apparently met another young Florentine interested in geography and science: Amerigo Vespucci, member of one of the city’s leading families and the future explorer whose name would be given to the New World. Leonardo’s connection with this family, of which we will hear more, is recorded in his *Notebooks*: “Vespuccio will give me a book of Geometry.” Amerigo’s uncle, the monk Giorgio Antonio Vespucci, was a famous scholar and humanist who donated his library to the Monastery of Saint Mark, where Toscanelli worked; Leonardo’s notes also contain references to “the library at St. Mark’s” and “the library at Santo Spirito” (the quarter where the Vespucci family—not to mention the Machiavelli—lived).

Leonardo also sought practical applications for his ingenuity. In the years after 1480, if not before, he began to draw designs for various machines and to explore the problems of controlling the flow of rivers like the Arno. Probably stimulated by a war in which Florence seemed besieged by Naples and the papacy, Leonardo also turned to military technology. He imagined a number of technical devices, such as a system of sliding beams that could be used to knock down the ladders of forces besieging a citadel (Figure 3.1). Often his agile mind would alight on a technological problem in the midst of work on a painting, so that a single sheet of his *Notebooks* shows one of his inventions along with the preliminary sketches for a work of art.

Although Leonardo doubtless met the humanist intellectuals who played a central role at the Medici court, these scholars championed Neoplatonic metaphysics and quotations from books rather than observation, experimentation, and practical know-how. Leonardo’s approach to scientific theory and invention was thus at odds with the views of the most influential scholars and intellectuals of the day.

In art as well, Leonardo’s conceptions were not conventional. At Lorenzo’s court, artists like Botticelli and Pollaiuolo flourished. Leonardo was critical of their poor sense of perspective and casual approach to landscapes. Instead of major commissions, Leonardo seems to have done little more than decorations for Lorenzo’s state pageants. In 1481, a number of Florence’s leading artists—including Botticelli, Signorelli, Ghirlandaio, and Perugino—received commissions to decorate the Sistine Chapel in Rome for Pope Sixtus IV. Leonardo was not among those chosen.

That year, at the age of twenty-nine, Leonardo finally received a major commission, an *Adoration of the Magi* for the monastery at San Donato. Perhaps the contract was due to his father, since Ser Piero did legal work for the monks. Certainly, Leonardo approached the task with great intensity and care, as can be seen from the extensive preparatory sketches that survive. As always, Leonardo sought perfection—and in this case, he achieved an astounding emotional intensity by breaking radically with the traditional iconography for the scene (Figure 3.2).

After completing the cartoon and beginning to paint the work, Leonardo abandoned it. Although such eminent artists as Botticelli,
Filippino Lippi, Ghirlandaio, Raphael, and even Michelangelo were amazed and influenced by what Leonardo completed, the Adoration was left unfinished. The reason remains a mystery. Some assume Leonardo stopped work due to his perfectionism and caprice, as with other commissions he failed to complete, or because his artistic solution was so difficult to execute. Others, however, suggest that it was the monastery that terminated the project, judging the painting too radical to accept.

In addition, there may have been another reason: money. The contract Leonardo signed with the monks was most unusual, offering title to a property rather than payment in money. The situation was quite disad-
vantagous in the short run, since Leonardo found himself without the cash to meet the contract’s provisions or even to pay for his paints. Why sign such an agreement?

Leonardo sought the independence to continue his studies of nature and technology. To have a studio of his own, he also needed money to support assistants. Routine painting commissions could not ensure that he would avoid the poverty and uncertainty that had often confronted his master, Verrocchio. This was an especially serious problem because Leonardo’s wealthy patrons often misunderstood and rejected his work as too radical. If Leonardo could complete the Adoration, the income-producing property that the monks were to transfer would ensure his financial independence.

Later in life, Leonardo was to show the importance he attached to becoming a property owner in the family tradition by fighting fiercely to gain his disputed inheritance from his father and uncle. The odd contract was thus a gamble that Leonardo probably took (and lost) in the hopes of gaining a steady income. After Leonardo abandoned the Adoration of the Magi, without money and support, he left Florence for Milan.

Leonardo went to the Milanese court of Ludovico Sforza not as a painter, however, but as a musician. Lorenzo de’ Medici counted music among his many avocations. Leonardo, whose beautiful voice and musical ability were widely admired, had invented a silver lute in the shape of a horse’s head. To cement a politically useful alliance between Florence and Milan, Lorenzo de’ Medici decided to give the lute to Sforza. Leonardo seems to have leapt at the chance to take it to Sforza’s court himself. He was to stay there for over eighteen years. They may have been the happiest years of his life.

Leonardo arrived in Milan in 1482 or 1483, accompanied by a young singer named Atalante Migliorotti. As his Notebooks make evident, by this time Leonardo knew his talent extended to engineering and science as well as music and painting, to the invention of weapons as well as sculpture and architectural design. He knew that his true worth had never been appreci-

ated in Florence. And he sought not only artistic commissions and wealth, but personal access and influence with the regent and de facto ruler, Ludovico Sforza (nicknamed Il Moro—“the Moor”).

It apparently took some time for Leonardo to make progress toward these goals. Because he did not at first gain a formal position at Sforza’s court, Leonardo joined the studio of the de Predis brothers. With Ambrogio and Evangelista de Predis, Leonardo received the commission for an altarpiece for the Confraternity of the Immaculate Conception: the Virgin of the Rocks. Once again, Leonardo broke sharply with traditional iconography. Whether due to Leonardo’s unconventional treatment of the theme or for other reasons, the friars refused to pay him in full. Leonardo protested.

In the years that followed, Leonardo worked in an astounding variety of areas. He continued to study vision and analyze painting as a science, writing what we now know as the Treatise on Painting (published only in the seventeenth century). He worked with the mathematician Luca Pacioli, illustrating his De Divina Proportione, finished in 1498 and published in 1509. He studied anatomy, completing dissections and exploring the precise structure of the human body. He developed skill as an architect, planning buildings of many types. He invented dozens of machines for both industrial and military purposes. And finally, he succeeded in gaining a position at Ludovico Sforza’s court.

Leonardo was eager if not desperate for public recognition, influence, and security. Because the Milanese were known for their suspicion of outsiders, he was limited in what he could achieve while working with the de Predis brothers. His Notebooks contain the draft of a letter to Ludovico Sforza, explaining the skills he could offer the ruler of Milan. This letter is not an advertisement for Leonardo’s services as a musician, nor even as a painter. Rather, it is focused on his abilities as a military engineer.

At the time, Milan was at war, particularly threatened by Venice until 1484 (when a treaty between the two cities was signed). Sforza, a proud and often devious man, generally preferred local talent to foreigners, and often pitted one “expert” against another. Leonardo, a Florentine artist in
Leonardo's offer: to create an equestrian monument to the Sforza family was taken seriously by Il Moro.

As this letter shows, Leonardo sought to establish a personal relationship with the ruler of Milan (offering to "explain myself to Your Excellence, showing you my secrets"). That is, Leonardo wanted to be a technical advisor who would not replace any current official or member of Ludovico Sforza's court (he offered his services "without prejudice to anyone else"). Leonardo was not just seeking a job—he was after a position as an influential, personal advisor whose primary responsibilities would be military technology and civil engineering as well as sculpture and painting.

Ultimately, Leonardo's attempt to gain employment from Ludovico Sforza was successful, and he became a member of the court, with a room in the ducal palace and a salary (which was not always paid). In Milanese documents, he is often listed as an engineer or architect—which suggests that his letter to Sforza had the desired effect. In fact, however, for some time his main functions were those of a kind of court jester and producer of festivals. During festivities, such as the Masque of the Planets performed in 1490 to celebrate the wedding of Gian Galeazzo Sforza (the legitimate heir to power) and Isabella of Aragon as well as Ludovico Sforza's own marriage to Beatrice d'Este, Leonardo designed and built scenery, pennants, costumes, and the pageantry Sforza used to astonish and please the assembled populace. Often Leonardo was engaged as a poet, storyteller, and singer: his Notebooks contain riddles from games played at the court and fantastic tales he apparently used to regale Beatrice and the other members of the court. Leonardo was frustrated by this frivolity: his Notebooks include entries complaining of the time-consuming chores of amusing the court, not to mention drafts of letters to Sforza asking that his long-overdue salary be paid as soon as possible.

In addition to these activities, Leonardo continued his scientific studies and worked on projects that reflected the abilities he advertised to Il Moro. Leonardo had promised to show Ludovico Sforza techniques for building bridges (Figure 3.3), for various kinds of siege equipment (Figure 3.4), for "mortars" resembling today's machine guns that fire shrapnel (Figure
for naval armaments of both offense and defense (Figure 3.6), for sapping and mining enemy fortifications, for constructing self-propelled armored vehicles like the modern tank (Figure 3.7), and other innovative ways to propel weapons. Interestingly enough, he also worked on “a method of letting a flood of water loose on an army, and bridges and walls of cities” by using a sort of “mobile lock.” From the drawings in his *Notebooks*, Leonardo seemingly fulfilled his promise to “contrive various and endless means of offence and defence.”

Although there is no evidence that Ludovico Sforza commissioned any of these devices, Leonardo’s images and technical notes show that he was deeply engaged in military technology and strategy. This interest was to persist. Some have said that Leonardo produced some prototypes while serving as Cesare Borgia’s military architect and engineer in the fall of 1502. The following year, he advised the Florentine government on ques-

![Figure 3.3. Leonardo, Wooden bridges. These easily constructed structures would provide a means to get soldiers across a river at a point dictated by military circumstances.](image-url)

![Figure 3.4. Leonardo, Siege equipment. This rope ladder for scaling a wall across a moat shares the simple technology of Leonardo’s early defensive technologies (as in Figure 3.1).](image-url)

...tions of military fortification. Although the diversion of the Arno to deprive Pisa of water and force its capitulation was not part of Leonardo’s original scheme for the river, this application of hydraulic engineering to warfare had been foreshadowed by his designs for a movable lock for Ludovico Sforza’s defense of Lucca, and by his later proposal that the Venetians flood the Friuli as a defensive measure against the Turks.

In the letter to Ludovico Sforza, Leonardo also offered to “give perfect satisfaction and to the equal of anything in architecture and the composition of buildings public and private.” During his early years in Milan, there were several major architectural projects for which there was vigorous competition. Foremost among these was the crossing dome to surmount the cathedral of Milan. When it became apparent that the tempo-
Figure 3.5. Leonardo, Sforza's cannon for the Sforza family. Artillery of this design was ultimately introduced in the American Civil War. Leonardo imagined many other types of firearms, including something like a machine gun.

Figure 3.6. Leonardo, Double-hulled structure and mysterious vessel for sinking enemy ships. Leonardo also designed underwater swimming equipment that would allow a diver to sink enemy ships by drilling holes in their hulls, but expressed fears at the consequences of using such devices.

There were numerous hesitations and many consultations. Three years later the commission finally went to Milanese architects—though Leonardo may have served as a consultant to those who completed the work. As the *Notebooks* reveal, Leonardo also drew plans for numerous buildings, including symmetrical churches, palaces, and fortresses.

Leonardo’s interest in architecture was not limited to individual buildings. In 1484, the plague hit Milan and ravaged the city for two years. Ludovico Sforza and the court—including Leonardo—fled to the countryside. Reflecting on the health risks associated with urban garbage and filth, Leonardo drew plans for an entirely new kind of city.

Leonardo’s urban planning was audacious. He conceptualized a city on multiple levels (like recently built shopping malls), with service functions on a lower level while the upper classes moved on special walkways at a higher level (Figure 3.9). These designs provided for watercourses, like modern sewers, to carry waste and drain rainwater in a healthy manner. To prevent the pressures of population from creating the conditions he
associated with the plague, Leonardo proposed a series of such planned towns, each limited to ten thousand inhabitants.

This view of urban and regional planning combined civil and domestic architecture with economics and politics. Leonardo saw the need to maintain the canals and watercourses on which the health of the new cities would depend. For that purpose, on the sheets of his architectural drawings, he proposed specific legislation requiring property owners along the shores of urban canals to provide maintenance. That is, Leonardo imagined a total reorganization of the way entire populations live “in time of peace.” In the words of a leading twentieth-century theorist of urban planning, Leonardo was the first person who “tried to survey and organize the natural forces of a whole region so as to serve human purposes.”

Although controlling the flow of water through a city was a component in Leonardo’s urban planning, it was listed separately in his draft to Ludovico: “I can give perfect satisfaction . . . in guiding water from one place to another.” There was no novelty in the attempt to control the flows of rivers, but Leonardo promised to be “the equal of any other,” if not to surpass the established hydraulic engineers.
Leonardo’s Notebooks from the 1490s show extensive reflection on redirecting rivers in order to reduce the dangers of floods and increase agricultural output. In his youth, Florence had repeatedly been flooded. Elsewhere, including Milan, floods occasionally did untold damage. Moreover, undrained swamps and shallow lagoons—particularly close to the sea—were areas known for poor health, due (as we now know) to malaria, among other things.

The rivers north of Milan, like the Adda, were the focus of some of Leonardo’s plans for canalization. Although these projects for “guiding water from one place to another” were not carried out by Sforza’s regime, many were ultimately financed by the French king Francis I in 1516.

While in Milan, Leonardo also began to consider the idea of moving the Arno. He worked on maps showing an extensive project to transform the Arno valley between Florence and the sea (Plates IV, V). Why, when working in Milan, would Leonardo develop a plan to straighten the channel of the Arno in order to create a rich agricultural valley and open Florence directly to the sea and therewith to naval commerce?

The answer may be related to Leonardo’s proposals for repairing and completing the Cathedral of Milan. In thinking about the structural problems involved, it is likely that Leonardo consulted with Luca Fancelli, the Florentine architect who had discussed the cathedral with Il Moro in 1487. In August of that year, Fancelli wrote to Lorenzo de’ Medici in Florence, proposing canals that would make the Arno navigable. Some suspect that these conversations led Leonardo to do extensive research on the problem during the following decade. Evidence for this view is found on a later map by Leonardo (Plate V) that indicates both Fancelli’s suggested canal from Florence to Signia (parallel to the winding course of the Arno immediately below the city) and several alternative routes for a much longer route through Pistoia. Whatever the inspiration, Leonardo was to pursue projects in hydraulic engineering as a professional expert for the rest of his life.

Leonardo’s projects for urban and regional planning were based on considerations that went beyond mere technology. In the 1490s, his Notebooks reveal an increasing commitment to write comprehensive scientific treatises on matters as diverse as the art of painting, human anatomy, the motion of water, physics, and geology. Among these manuscripts is a notebook with the entry “On the 2nd of April 1489, book entitled ‘On the human figure.’” Elsewhere in the same notebook, Leonardo wrote: “And so may it please our great Author that I may demonstrate the nature of man and his customs, in the way I describe his figure.”

In addition to technology and science, Leonardo completed many paintings during his years in the Sforza court, including the Lady with an Ermine (now in Cracow), Madonna Litta (now in the Hermitage of St. Petersburg), La Belle Ferronière (now in the Louvre), and the Musician (now in Milan’s Ambrosiana). Among his last works in Milan, started in 1498, were decorations for the Salle delle Asse in Sforza’s castle. But most important of all, Duke Ludovico sponsored a large fresco in the refectory of a Dominican church, Santa Maria delle Grazie: the Last Supper.

Leonardo received the commission for the Last Supper in 1493. For several years he drew preparatory sketches while working on his many other projects. Once the cartoon was completed, Leonardo set up scaffolding in the refectory. To the annoyance of the prior, however, the painting progressed slowly. It is said that Leonardo would arrive in the hall, look intently at the painting for as much as two hours, add a single stroke, and leave again. In 1497, a memorandum by Ludovico ordered one of his subordinates to urge Leonardo to finish the painting so that he could work on another wall of the refectory.

Leonardo paid special attention to the faces painted for each of the apostles, seeking features appropriate to each character while he walked the streets of Milan, and then inserting the image into the painting. According to one account, when all that remained to complete the Last Supper was the face of Judas, the prior of Santa Maria delle Grazie lost patience and asked Ludovico to order Leonardo to finish. Leonardo supposedly explained to the duke that he was still seeking the perfect face for Judas, but that if not allowed to find it, he would have to use the second best he had seen—the prior himself. Il Moro let Leonardo finish as he wished.

Leonardo was not particularly known for sculpture before going to
Milan, even though his master, Verrocchio, was among the leading sculptors of the age. In promising Ludovico Sforza that “the bronze horse may be taken in hand, which is to be the immortal glory and eternal honour of the prince your father of happy memory, and of the illustrious house of Sforza,” Leonardo was relying in part on skills he had learned as an apprentice but had not fully exploited as a mature artist.

The story of the commission for this statue shows that the connection between art and politics was often very close. After many other artists had been consulted, Leonardo finally received the commission in 1489. His first designs for Il Cavallo, as he came to call the project, were for a life-size statue. Then it was decided to make a truly grandiose monument. The largest known equestrian statue cast in bronze since antiquity was Verrocchio’s monument to Colleoni, the Venetian condottiere. That statue was thirteen feet high (horse and rider combined). Leonardo imagined an equestrian statue in which the horse alone was twenty-four feet in height.

At first, to make the statue more imposing, Leonardo conceived of a rearing horse (Figure 3.10). Because his design would require that the huge weight of the statue be supported only by its hind legs, with a foreleg supported by the body of a fallen warrior, Leonardo ultimately chose a less difficult path. Even so, the design presents a trotting horse of amazing vitality and force. The conception of such a statue and its realization in full-scale clay was—as Leonardo complained—delayed by Ludovico’s insistence on other tasks in the court.

Finally completed in 1493, the clay statue of Il Cavallo, ready for casting, was put on display in the courtyard of the duke’s palace. It would be an understatement to say that this statue astounded those who saw it. Based on Leonardo’s extensive studies of anatomy, the form seemed to be in lifelike motion. Yet its gigantic scale, surpassing anything that contemporaries had seen, made an even greater impression. But even after he overcame the obstacles to such a grandiose sculpture, Leonardo’s problems were not over.

No one knew how to cast a bronze statue of this size. In the end, about 158,000 pounds of bronze were set aside for the monument. Leonardo set about to solve the technical problems posed by both size and weight, inventing a radically new way of casting a large statue. Then the bronze designated for the statue was diverted for the casting of cannon to defend Milan against the French. Perhaps the clay statue merely crumbled with age. But according to one story, when the forces of King Louis XII under Charles d’Amboise captured Milan in 1499, French troops camped in the ducal castle. Bored but in high spirits, as troops can be after victory, they began using Il Cavallo for target practice. Before Leonardo’s eyes, the story goes, they destroyed what many thought was the most extraordinary statue of the age.

Il Cavallo is a fitting symbol of Leonardo’s stay in Milan, where he perfected his genius in many fields and gained—for the first but not the last