

The Work of Leonardo da Vinci:

From the Mind of a Genius

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Introduction

It was in the middle of last fall when I found the quote. Tucked neatly into the margins of an uninspired, yet overrated, manual for aspiring artists was a quiet apology:

“I have offended God and mankind because my work
didn't reach the quality it should have.”

- Leonardo da Vinci

(Lang, 61)

An overwhelming sadness washed over me as I pondered his words. I wondered if his statement was indicative of his own self-reflection on life unfulfilled. Perhaps he was unable to ever truly see in himself as a wonder, a truly awe-inspiring artist and inventor. The emotional pull of that tiny comment continued swimming through the back of my mind. Over the next several months, I returned to it, again and again, as I pieced together my own image of Leonardo da Vinci.

The possibilities framed within the apology is staggering. It presents near-disastrous notions regarding the legitimacy of the renaissance polymath artisan by both the standards of his time, and our own contemporary idea of artistic value. The book, in which the quote had been inserted, was a blasphemous oversimplification of the current art world, in all its grotesquely glorified commercialism. Aside from Leonardo's quote, I found the text to be completely useless. That said, I could not fathom leaving the statement unresolved in my mind.

In the ways that all small revelations lead one to charge ahead towards greater knowledge, this quote birthed inside me the need for a real, true understanding of the artist who lived a full five centuries before my time. Leonardo is unquestionably the most enigmatic and revolutionary polymath I have encountered in my studies, and I wanted to know more about the roots of his creative genius. Through researching both the context of his personal and historical records, as well as scientific literature on the current understanding of the mind and creativity, he has transformed into a man with

whom I can identify, as well as find great inspiration.

This consideration of his life and mind has elicited my own response to Leonardo's quote. If I had been the ears to which it had been revealed, I would have been inclined to defend his honor fiercely. Perhaps, through this very writing, I will find the means to justify his own great works to the spirit of Leonardo. If any mere mortal today should accomplish as much, he would undoubtedly be living as a superhero, a champion for the modern merger between the arts and sciences.

The focus of this paper will be to examine his life and work, through the lenses of historical context and our modern understanding neuroscience. Reviewing his origins and environment, in combination with data from current neuroscience studies and their potential implications, we will derive a more fully developed understanding of the creative genius of Leonardo da Vinci. It is in this capacity that I hope to form a more cohesive portrait of the artist, combining that soft spoken statement of humility I found between those quotation marks with the legendary icon of art and science we know today.

The Life of Leonardo: The Creation of a Renaissance Polymath

During the dark night on April 15, 1452, in the small hamlet of Vinci, a young peasant woman named Caterina gave birth to a son. Her son was the illegitimate offspring of a local notary, a man named Ser Piero da Vinci. The full birth name, Lionardo di Ser Piero da Vinci, was ascribed to a boy of substantial talents.

Early accounts of Leonardo's childhood were recorded by Giorgio Vasari, a sixteenth century art-historian noted for his biographical writings on famous Italian artists. Vasari considered Leonardo to be a “truly marvelous and celestial” young boy with exceptional abilities. So incredible was Leonardo's aptitude for learning, “that he would have made great proficiency if he had not been so variable and unstable.” (Vasari, 9) His thirst for knowledge, to which Vasari points, caused Leonardo to perpetually begin a multitude of projects, only to abandon them a short time later. It is this continual

upheaval in his behavior that may have impeded his learning growth from achieving the magnitudes to which his apologetic quote alluded.

The sole constant unchanged by his upheaval of attention was his affinity for drawing and sculpture. His artistic ability was profound, never waning from the forefront of selective attention, and greatly enhanced by his move from Vinci to Florence during childhood.

The Florence of his youth was a bustling epicenter of the Renaissance Humanist movement. The streets were brimming with newly emphasized scholastic endeavors. The city was the perfect environment to spark creativity and provide a wealth of educational opportunities to the young Leonardo. As he grew, his artistic achievements proved to be remarkable.

At 15, Leonardo's father sent the young prodigy to apprentice under the master artist Andrea del Verrocchio. It was in Verrocchio's workshop that Leonardo was able to further hone his artistic talent, expanding his skill sets through diligent observation and note taking. It was these years as the adolescent apprentice to Verrocchio that provided Leonardo with the pathway towards emergence as a world renowned master artist. Verrocchio's training, combined with the inspirational urban environment of the city, catapulted the young Leonardo into the professional world after only 6 years in his apprenticeship program.

By the age of 30, Leonardo had established himself as an artistic force in the city of Florence. Soon after, the young Leonardo submitted a resume to the Duke of Milan which highlighted his abilities to solve any and every militaristic challenge that might be encountered, while his artistic achievements were listed in marginal importance. He was hired by the Duke of Milan, Ludovico Sforza, for his services as an engineer and painter. His work in Milan shed new light on the unfurling of his creative genius.

Leonardo's designs for militaristic weaponry and machinery are impressive examples of his imagination at work. Several of his designs border the impossible, merging fantastical aspects of

dream-like aesthetics with improbable functional capacity, such as his design for a tank (Figure 1.) Yet other designs appear to have the potential to lead to the creation of working models, and some even bear resemblance to modern machines, like his designs for an early automobile (Figure 2). Although many of his inventions are impractical, his notebooks were flooded with sketches and writings on almost every subject imaginable.

His ever-changing plethora of new ideas created a continual stream of new directions for his studies. His continuing pursuits in the name of his studies led him through Venice and a return trip to Florence, where his professional achievements were celebrated. Once again, he left Florence and took employment under Cesare Borgia, the son of Pope Alexander VI. His keen abilities to style his talents to suit his patrons' needs led Leonardo to become very skilled in architecture and map-making. It was also during this time that he perfected his understanding of anatomical and physical sciences.

His great skill as a concept artist was largely unrealized during his lifetime. A primary example was his unworkable plan to bypass an unnavigable stretch of the Arno river by building a large canal that connected Florence to the sea (Figure 3). His detailed design notes used his own measurements to create an accurate map of the terrain. Several centuries after penning his mind's images, an express highway was built on the exact route he had once imagined. His detailed reference notes have become a trans-temporal legacies, bequeathing his wealth of knowledge to his future mankind.

The Mind Behind the Incredible Artistic Legacy

The exceptional legacy of Leonardo da Vinci lies in his abilities as a polymath, literally transforming all aspects of his life into varied art forms. He was able to recognize the the true beauty of the world around him. His mind was able to tap into an unparalleled level of creativity. Creativity so incredibly overwhelming that his work, and its purpose, is still the source of much inspiration and debate to this day.

I will assert the very nature of his neural hard-wiring, and the elegance of his genetic makeup, gave rise to the wonders on his processes. His mind produced an unparalleled creative access, a veritable floodgate of new thoughts and ideas. With these blessed gifts, however, was a shared struggle with his human identity. His natural thought processes led to an abundance of exploration. Leonardo was forever curious about the natural world. His inquisitive nature was nearly uncontrollable, raging at lightning speed across the gamut of subjects. His prolific studies produced incredible compendiums of extensive information about a great range of subjects, from engineering, optics, and mathematics to geological and botanical surveys.

Leonardo was the original idea-man, the strongest conduit for creative inception of the time. This notion immediately produces apparent difficulties in attempts to reign in that level of creative intensity. It must have been a ridiculous task to attempt to keep records given the sheer rate of flow at which his ideas were spontaneously generated. His ability to transform his ideas into an early graphical interface, diagrams and notations, was unprecedented. And that aspect of his unique process is no less than incredibly impressive.

In the spirit of linking creative neural networking with cosmically driven evolutionary intelligence, I refer to his renowned mirror writing technique as a tangible example of novel processing abilities. The documentation of his own behavior in his early years still provides sufficient data to test theories using rigid scientific inquiry. A recent and rather unremarkable event (by most accounts) in my own existence led me to further theorize on the potential possibilities and implications of his writing techniques.

A Genius Wired for Creativity

I came home one recent afternoon to notice my daughter's very precise mirror-writing on the cement back patio. She had been doodling all sorts of affectionate scrawl while my husband worked in

the yard. Her writing originated to the left of a large heart and continued on the whole way across the cement. Multiple times she began again, drawing another heart, and writing a sentence. It was very much as if she had simply begun writing in the next possible location, and repeated the process, only to have the occurrence read perfectly both left to right and backwards.

I stood in impressed silence. Within seconds, my mind managed to wander back to Leonardo's own famed writing. I imagined his process to be similar, due primarily to the structural function of his brain. With these ideas, I began to form a hypothesis about his thoughts and behavior, turning to scientific research to support my claim. I hypothesized that my daughter's capacities for inherent mirror-writing abilities, and Leonardo's, shared similar traits found in the makeup of the brain. Specifically, I questioned whether hemispheric division was apparent in a more reduced form in both cases.

My initial research on the subject produced a study on the propensity for spontaneous mirror-writing among Canadian children (Cornell, 1985.) The research results indicated that spontaneous mirror-writing was reflected only in participants under the age of 8. I inferred that average neural development prior to age 8 showed less pronounced hemispheric control of specific faculties. The brain has not yet truly forged a discriminating divide between the two hemispheres, thus output flows freely in, quite literally, any direction.

Leonardo would be the grand exception, his omnidirectional flow remaining long past early childhood. His mind bears apparent similarities to those of the aforementioned children. It certainly would have retained a progressive form of neural plasticity that redefined his ability to conceptualize the surrounding world. Pondering this information led me to posit that unique neural networking and brain activity are strongly correlated with the concept of creativity, as we currently define it.

Additional research on mirror-writing indicates it may be an inherited trait, it's appearance symptomatic of an atypical language organization in the brain. Sometimes trauma or physiological

events will trigger the spontaneous onset of adult mirror-writing, as discussed in a recent case study conducted by Nakano, Endo, and Tanaka (2003).

The young female subject exhibited multiple attributes similar to those of Leonardo da Vinci. Among these similarities was an inclination towards ambidextrous coordination, and a creative affinity for painting and sculpting. She wrote entirely in mirror-form, with the exception of material intended to for an external audience. Testing revealed above average intelligence, noting superior recall and performance abilities. It is particularly interesting to note that she mirror-writes with her dominant right hand, while any forward scrawl is created using her left.

Nakano, et al., asserts “the mechanisms responsible for the onset of mirror writing. in our patient are related to her ambidexterity, incomplete laterality of the hemispheres,...and disturbances of sensation as represented by the sensation of eye rotation. In addition, the onset of mirror writing may have been promoted by the patients habit of viewing objects from various angles, or rotating them in her imagination, when painting and sculpting them.” (Nakano, et. al., 14.)

It is certainly possible that her creative mind encountered a physiological event that necessitated spontaneous rewiring of her mechanical ability. Or perhaps hemispheric lateralization of the subject's brain has remained less defined, conforming with the hypothetical nature of Leonardo's demonstrated handedness. He kept notes mainly for himself, the resulting direction would be the most natural and comfortable format. It is entirely possible that his left hand was dominant, with any subsequent alterations in mechanical performance following suit.

Additional studies provide clues to the neurological nature of Leonardo's hand-writing. Schott (1999) discusses the marked differences between organic habitual mirror-writing and pathological acquisition of the ability, characterized as “generally poorly formed...suggesting use of normally inactive processes.” (Schott, 2160.) Schott concludes that writers like Leonardo, displaying seamless mirror-writing abilities, identify a possible cognitive connections between the two processes.

The brain has a miraculous means of rewiring itself when necessary, as if to relocate information to the next best area for productivity. Though Leonardo may not have always acknowledged the blessing of novel thought processes, his mind is certainly the product of a genetic leap forward. After substantial review, there is strong evidence to suggest that Leonardo's writing was more a misunderstood neurological indicator of increased capacity for crossover processing information. He kept notes mainly for himself, the resulting direction would be the most natural and comfortable format.

A detailed transcription given by author Michael White in *Leonardo: The First Scientist* (2001) shows the depth to which Leonardo recorded his experiences.

Driven by an ardent desire, and anxious to view the abundance of varied and strange forms created by nature the artificer, having travelled a certain distance through overhanging rocks, I came to the entrance to a large cave and stopped for a moment, struck with amazement, for I had not suspected its existence. Stooping down, my left hand around my knee, while with the right I shaded my frowning eyes to peer in, I leaned this way and that, trying to see if there was anything inside, despite the darkness that reigned there; after I had remained thus for a moment, two emotions suddenly awoke in me: fear and desire – fear of the dark, threatening cave and desire to see if it contained some miraculous thing.

(White, 74.)

White maintains the entry is typical of the types of reveries recorded by “avid keepers of notebooks.” (White, 74.) The remarkable attention to detail to which Leonardo bestows upon his interests provides clues to aid in future research. A man ahead of his time, Leonardo's understanding of the world continues to pace itself ahead of the curve.

This journal entry has also spurred its own research into the areas of handedness and lateralization. McManus and Drury (2004) created the “Leonardo task,” (which mimicked the his description above), using variables in crouching postures to test the hypothesis that Leonardo's left-handed mirror-writing was acquired later in life. “A simple analysis in a large number of modern subjects showed, however, that the laterality of the Leonardo task was hardly related at all to handedness, conventionally defined as writing hand.” (McManus, et. al., 2004.) The researchers concluded that there was no clear indicator in the description provided by Leonardo's journal entry to provide definitive evidence of the artist's natural handedness. The apparent flexibility in handedness coordination that is demonstrated in equally perfected scripts written both forwards and backwards suggests a greater link to his overall creativity through generalized and overarching neural processes.

In a similar capacity, the bane of his working life also provides glimpses into the mind of the great artist. Leonardo's inattentive behaviors and his continual inability to complete projects may be the end product of unusual brain activity. A study conducted by Takeuchi, Taki, Hashizume, Sassa, Nagase, Nouchi, and Kawashima (2011) shows “an association between brain activity during a working memory task and creativity.” (Takeuchi, 681.)

The precuneus, a key site in the Default Mode Network, the areas of the brain active during states of unfocused, wakeful rest, shows reduced deactivation during working memory tasks. Hidden within the longitudinal fissure between cerebral hemispheres, the precuneus is involved with visual-spatial processing and episodic memory. Introspective reflection and consciousness are also actively represented within the site. The results of the study “indicate that individual creativity, as measured by the divergent thinking test, is related to the inefficient reallocation of attention, congruent with the idea that diffuse attention is associated with individual creativity.” (Takeuchi, et. al., 681.)

Divergent thinking, a trait associated with increased creativity, is often measured by the ability to solve problems by generating a larger number of more complex solutions. Ideas trigger expansive

thought processes on which the creative intellect elaborates. The ability to gather resources from multiple domains provides the thinker with greater problem-solving abilities.

A secondary study of connectivity, conducted by Takeuchi, Taki, Sassa, Hashizumea, Sekiguchi, Fukushima, and Kawashimaa (2010), shows an increase in the integrated white matter tracts. “These pathways...connect information in distant brain regions and underlie diverse cognitive functions that support creativity.” (Takeuchi, 12.) The results indicate creativity is related to the ability to link “conceptually distant ideas held in different brain domains and architectures.” (Takeuchi, 12.)

Leonardo da Vinci was exceptional in integrating vastly different areas of his existence to create a cohesive vision. The broad scope of his legacy is consistently reflected in the results of modern scientific research. It is in this capacity, that Leonardo lived and breathed art, his very existence the perfect example of true master artistry realized.

The Double Helix: Art & Science Intertwined

There is a great divide between subject fields in contemporary society. This unfortunate segregation of ideas inhibits the expansion of a more holistic interpretation of both the definition and meaning of art. Inside these days, art and science remain separate subjects, much to the detriment of progress.

The concepts regarding subjects viewed have become too rigid – art is art, with science removed from the equation. The interconnectedness of the natural world has been de-emphasized over time, modified in the face of modern civilization. An examination of nature, however, reveals a cosmic science behind our creation, its work by the ultimate Master Artist. It appears that when we intentionally expand on the original blueprints provided of the natural world, we are able to truly flourish.

As technology advances, scientists return to the work of Leonardo to puzzle over the intensity

and accuracy of his incredible abilities. As modern science struggles to gain pace with the scope of his originality, we often discover a startling accuracy in his investigations of the world, as demonstrated by his contributions to multiple subject fields, particularly neuroscience.

Pevsner (2002) expands upon Leonardo's affinity for the interconnectedness. "Through his studies of the brain, Leonardo provides us with a fascinating view of the intersection of his art and science. Today we see these as activities in separate domains, but to him painting *was* a science, and to see was to know. Leonardo created a theory of sensory perception from the input of sensory stimuli to their processing in the brain." (Pevsner, 219.)

The innate propensity for merging multiple facets of an extensive knowledge base, Leonardo was able to transform the medium of painting into new creative dimensionality, replete with rich dynamic interplay. His evolving understanding of geometry, engineering, and the human psyche provided a revolutionary means of artistic communication. This idea is best articulated through his masterpiece, the *Mona Lisa* (c. 1503-1519). (Figure 4)

Leonardo's *Mona Lisa* is often considered the pinnacle of artistic achievement. The mystery surrounding the advent of the icon has become the foundation of speculative inquiry on the psychology behind artistic expression. Chakravarty (2010) uses the painting to introduce the concept of "dynamism," stating a relationship between increases in cortical activation in the viewers brain and increases in levels of appreciation for the object viewed. "A painting/sculpture generally evokes aesthetic experience through activation of areas V1/V2, V3 and V4. If V5/MT, the motion area, can also be activated (truly as in a movie or through imaginative frontal activation as discussed earlier), the aesthetic value or appreciativeness of the art form can be enhanced." (Chakravarty, 70.)

Chakravarty suggests that Leonardo painted the subject's mouth to introduce an element of implicit dynamism, an imagination of movement of a smiling face, in the painting to increase the aesthetic value of his artwork." (Chakravarty, 72.) Leonardo's understanding of a dynamic aesthetic

would exponentially enhance the value of his work. Chakravarty suggests Leonardo possessed a profound knowledge of human anatomy that predated the discovery of the V5/MT area by centuries. “It seems Mona Lisa has really something to smile about now that the puzzle appears to have been solved!” (Chakravarty, 72.) As Chakravarty has so eloquently described, the multifaceted *Mona Lisa* stands as an example of the subtle perfection of product attained through the merger of art and science.

It is in his incredible capacity for constructing multidimensional solutions and his ever-expansive knowledge base that Leonardo has excelled in genius. I point to his perceived inability to complete the tasks at hand, his perceived procrastination, and maintain that any negative perceptions of those qualities are immediately evaporated by the crowing triumph of Leonardo's very existence as the ultimate achievement in art history.

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Figure 1

Design for Military Tank

Leonardo da Vinci

c. late 15th-early 16th century

[://www.leonardo-da-vinci-biography.com/images/da-vinci-invention-tank.jpg](http://www.leonardo-da-vinci-biography.com/images/da-vinci-invention-tank.jpg)

[://upload.wikimedia.org/wikipedia/commons/b/b9/Leonardo_tank.](http://upload.wikimedia.org/wikipedia/commons/b/b9/Leonardo_tank.)

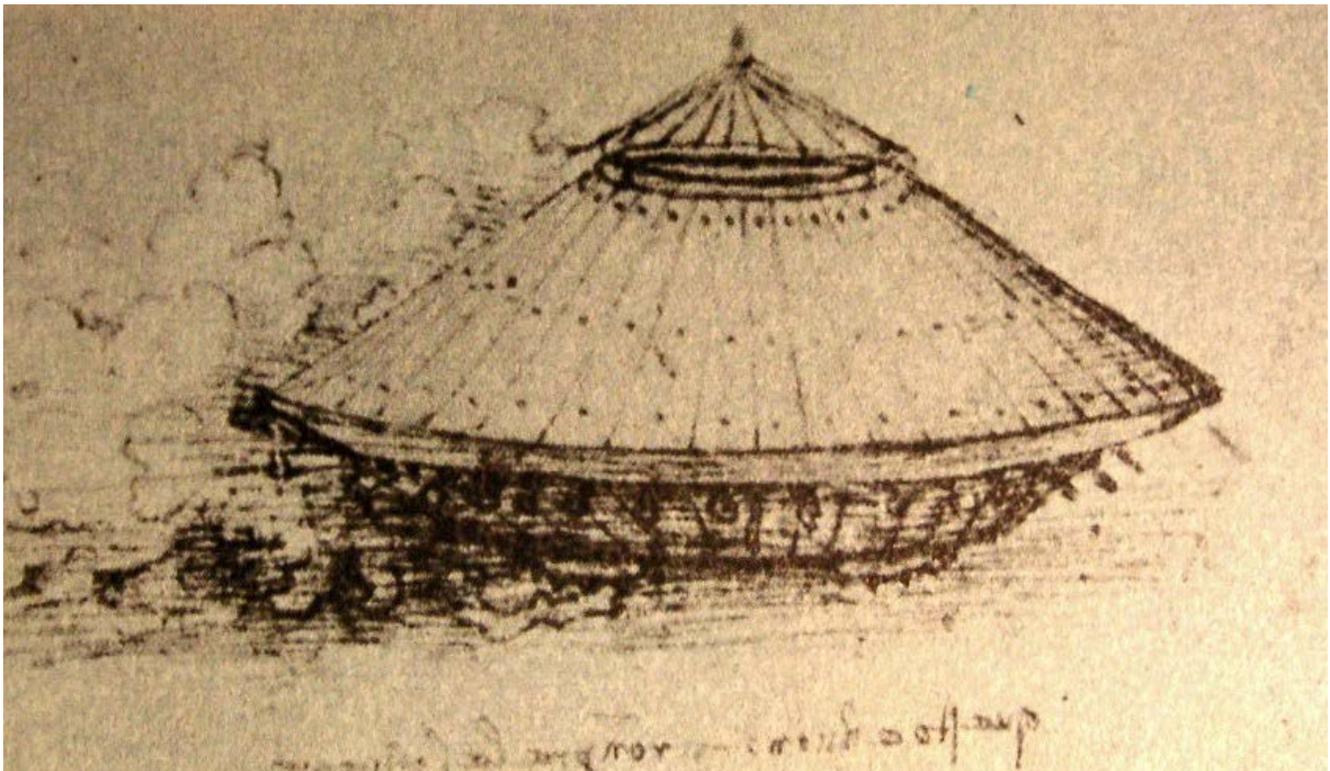


Figure 2

Designs for an Automobile

Leonardo da Vinci

c. 1478

[://www.leonardo-da-vinci-biography.com/images/da-vinci-invention-automobile-car.](http://www.leonardo-da-vinci-biography.com/images/da-vinci-invention-automobile-car.)

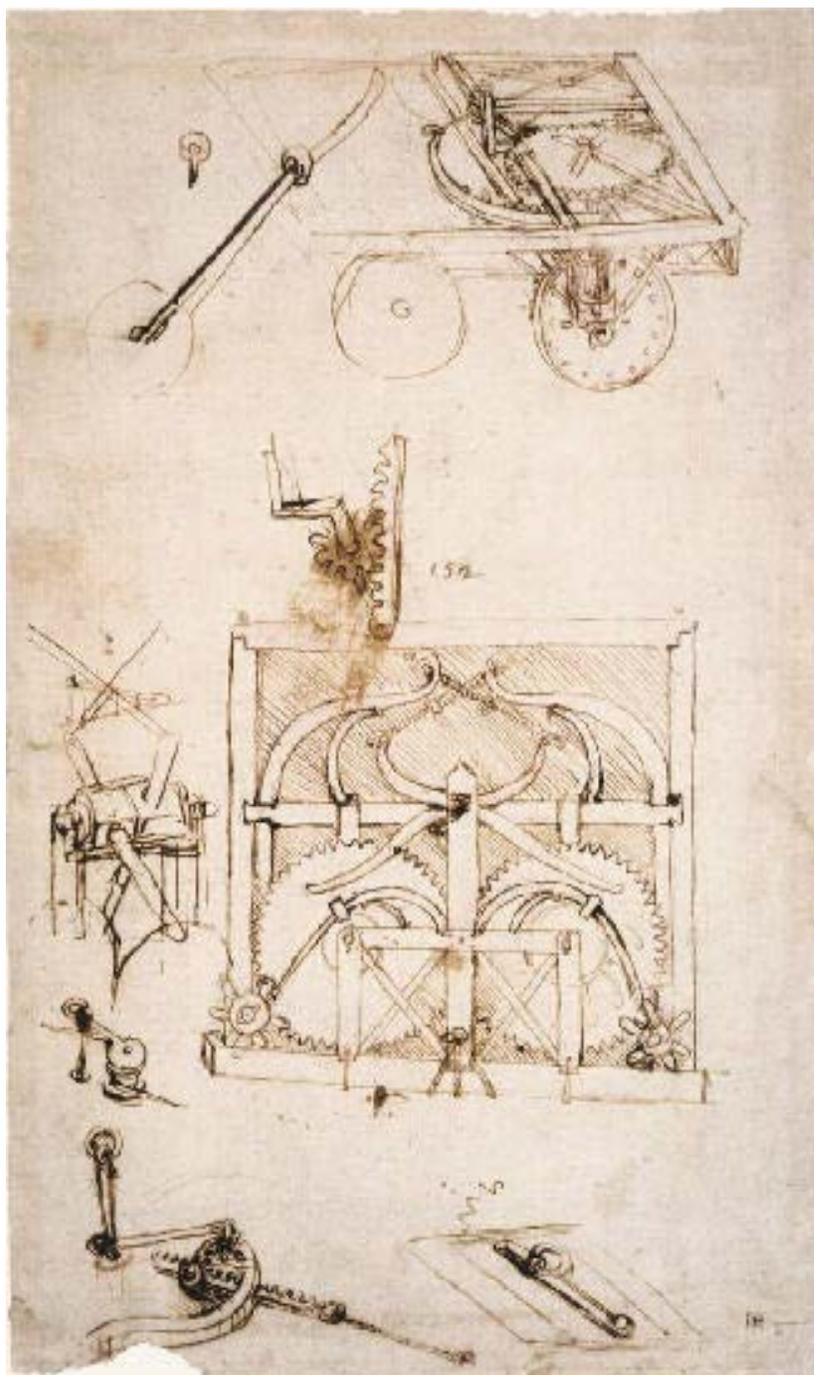


Figure 3

Map of the Chiana Valley, Tuscany

Leonardo da Vinci

c. 1502

[://commons.wikimedia.org/wiki/File:Valdichiana_at_Leonardo's_times.](https://commons.wikimedia.org/wiki/File:Valdichiana_at_Leonardo's_times.)

