Leonardo da Vinci
Overview of Chapter 2

- Knowing How to See
- Leonardo's 'Cosmography' of the Body
- 'Seeing' Systemically
- Imagination: The Rudder and Bridle of the Senses
- Making Machines
- Making Masterpieces
- Implementing Leonardo's Strategies
  - Developing Perceptual Filters
  - Leonardo's Strategy for Systemic Thinking and Invention
- Conclusion
Leonardo da Vinci: Mapping the Microcosm

No person represents the European Renaissance more in spirit and achievement than Leonardo da Vinci (1452-1519). A painter, sculptor, draughtsman, scientist, inventor, engineer, architect and musician; Leonardo's voluminous notebooks cover topics as diverse as astronomy, human anatomy, optics, painting techniques, mathematics and even manned flight. His understanding of the human body, the laws of nature, and physical mechanics were centuries ahead of his time. His paintings such as the *Last Supper* and the *Mona Lisa* set the standards for renaissance art and still stand today as some of the world's most outstanding examples of Western art.

In the previous chapter we examined Freud's analysis of da Vinci, in which he asserted that Leonardo's exceptional abilities were a result of the 'sublimation' of his sexual impulses. Freud explained Leonardo's intense passion for art and scientific exploration as being the outcome of the redirection of his sexual desires towards intellectual and artistic pursuits instead of romantic activities. Freud claimed that this pattern of behavior came from Leonardo's early childhood experiences involving his illegitimate birth, his separation from his natural mother at an early age, his lack of bonding with his father, and what Freud inferred to be the development of passive homosexual tendencies due to the interruption of his childhood "sexual researches."

While Freud's analysis is stimulating and provocative, it does little to reveal much about the actual process of Leonardo's creative or scientific abilities. By Freud's own admission, he was not able to illuminate any of the key mental mechanisms behind Leonardo's "artistic talent and capacity." Instead, he had provided a unique and fascinating explanation for 'why' Leonardo had developed that capacity.

Unlike Freud's analysis, the NLP study of Leonardo cannot merely be intellectually satisfying or provocative - it must be practical. Our conclusions must be effective for reaching some goal.
Section 1: Knowing How to See

By using the cognitive filters of NLP to examine Leonardo's notebooks we can obtain some valuable insights into his thinking processes. For instance, given his artistic and observational skill, it is not too surprising to find that Leonardo was primarily a visual thinker. He writes:

"The eye, which is called the window of the soul, is the chief means whereby the understanding may most fully and abundantly appreciate the infinite works of nature; and the ear is the second, inasmuch as it acquires its importance from the fact that it hears the things which the eye has seen. If you historians, or poets, or mathematicians had never seen things with your eyes you would be ill able to describe them in your writings. And if you, O poet, represent a story by depicting it with your pen, the painter with his brush will so render it as to be more easily satisfying and less tedious to understand...Inscribe in any place the name of God and set opposite to it His image, you will see which holds the greater reverence! Since painting embraces within itself all the forms of nature, you have omitted nothing except the names, and these are not universal like the forms. If you have the results of her processes we have the processes of her results." (MS. 2038 Bib. Nat. 19 r and v)

Leonardo's statement expresses a clear preference for the visual representational system in his thinking and omits the senses of feeling, taste and smell altogether. Leonardo believed that the eyes were the highest of the sense organs and that sight alone conveyed the empirical facts of experience immediately and with the most certainty.

Like some other creative geniuses (Albert Einstein, for instance), language takes a secondary role for Leonardo. He views it as a way to name or describe discoveries, not to make them. It is obvious that in Leonardo's notebooks the drawings are the focal point, not the words. That is, his pictures were not intended as simply 'illustrations' of his notes; rather, the notes were intended to be comments on the pictures.

On the other hand, Leonardo's focus on the visual sense stands as a marked contrast to Freud's strong emphasis on language and verbal processes. As a result, many aspects of Freud's way of thinking were quite different from Leonardo's. For instance, da Vinci claimed that vision was the "chief means whereby the understanding may most fully and abundantly appreciate the infinite works of nature." Freud, however maintained that it was "by words one of us can give another the greatest happiness or bring about utter despair; by words the teacher imparts his knowledge to the student; by words the orator sweeps his audience with him and determines his judgments and decisions."

Leonardo saw painting as the highest of all the arts, claiming it was "more easily satisfying and less tedious to understand," and asserted that "Since painting embraces within itself all the forms of nature, you have omitted nothing except the names, and these are not universal like the forms." Freud, on the other hand, stated that he was most affected by "literature" (which is verbal), somewhat by sculpture, and only "less often painting," maintaining that "Words call forth emotions and are universally the means by which we influence our fellow-creatures."

From the NLP perspective, Freud and Leonardo are classic examples of two different 'primary representational systems' — Freud's primary system was 'verbal' and Leonardo's was 'visual'. Their argument about how people "understand" and are influenced by the world around them are more projections of their own representational strategies than statements of the 'truth' about reality. In fact, from this point of view, it is easy to understand why Freud found da Vinci so fascinating and yet so incomprehensible. Freud would not have been able to easily relate to Leonardo's experience of the world. Where Freud would have rationalized and explained "why" something had happened, Leonardo watched and drew "how" it happened.

Thus, Leonardo's eyes were his primary channel for interacting with and understanding the world around him. Super vedere ("knowing how to see") was what Leonardo called his primary tool for uncovering the "universal forms" and "processes" behind the
“results” of nature’s creations. For Leonardo, the gateway to discovery and insight was direct observation and experience.

Leonardo claimed, “Science comes by experience not by authority,” and often signed himself “disciple of experience.”* As he put it:

One calls mechanical that discipline that derives from experience, scientific that which has its origin and conclusion in the mind, and semi-mechanical that which originates in a theory but ends in a manual activity. But to me all sciences seem vain and full of error that are not born of experience...and do not terminate in actual experience; or to put it another way, those of which neither the beginning, nor the middle nor yet in the end is made known to one of the five senses...the true sciences are those which become known to us through our senses by experience. (CU 19r-v)

Leonardo asserted that science should be “born of experience” and “terminate” in experience. Claiming that “the senses are the ministers of the soul,” he maintained that either the “beginning,” “middle” or the “end” of the process which one was studying should be “made known to one of the five senses” through observation.

Certainly, Leonardo’s own powers of observation must have been remarkable. The drawings in his famous Codex on the Flight of Birds revealed details that no one else was able to discern until the invention of high speed photography.

* Even though their representational strategies were different, this is one area where da Vinci and Freud were aligned, for Freud too maintained, “It remains true in scientific matters it is always experience, and never authority without experience, that gives the final verdict, whether in favor or against.”

Of course, Leonardo’s scientific and artistic capacity, which was both prolific and productive, was a function of something more than simply being a good visual observer. For Leonardo, “knowing how to see” involved the ability to connect visual observations to cognitive and behavioral processes as well. It required the capability to create both internal and external representations of what one has perceived. As he maintained in his treatise on painting:

The true and scientific first principles of painting establish what is the opaque body, primitive and derivative shadow, what is lighting, that is, darkness, light, color, volume, the placing of figures, distance, proximity, movement or repose. All these take place in the mind without any manual activity. This constitutes the science of painting, which is in the mind of the theorist who conceives it; from it issues the execution which is much more noble than the theory. (CU 19r-v)

In his comment, Leonardo talks about the “science of painting,” which he relates to the discrimination of what are called ‘submodalities’ in NLP (i.e., brightness, color, movement, etc.). According to Leonardo, the perception and discernment of the interrelations between these qualities takes place in the “mind of the theorist” and form the basis for the “execution” of the painting. Leonardo’s statement that the “execution” is “much more noble than the theory” shows that he placed more value on the instrumental application of the theory than the theory itself.

In this treatise, Leonardo makes the assertion that it is only the individual who had both the subtle powers of perception and the ability to pictorialize those perceptions who is in a position to achieve true knowledge. He perceived drawing as an instrument for formulating and transmitting knowledge that could be applied to any field of human endeavor. For Leonardo, knowledge was obtained by first observing some phenomenon and then represent-
ing it clearly and completely in a pictorial manner. Leonardo gained knowledge of something by producing and interacting with his own external representations of it. And in doing so, he developed a kind of graphic representation which he called *dimontrazione* (demonstrations), which established the basic principles for modern scientific illustration.

Thus, Leonardo's basic strategy for gaining knowledge through "knowing how to see" involved the interaction between three fundamental elements:

1. sensory experience,
2. internal cognitive maps, and
3. externalized visual maps.

The external maps were a "demonstration" of what had been internalized from sensory experience.

Leonardo's Basic Strategy for "Knowing How To See"

In his treatise on painting Leonardo even describes some very specific ways to develop this strategy on a concrete personal level.

1. Drawing the same thing a number of times using an external model.
2. Drawing it without the model.
3. Making a tracing of the model on glass.
4. Placing the tracing of the model over the drawing you made without the model.
5. Noting the discrepancies between your drawing and the tracing of the model.
6. Repeating this same cycle again focusing only upon drawing those areas where your representation deviated from the tracing of the model.

In the model of NLP, the kind of process defined by Leonardo is known as a T.O.T.E. (Miller, et al, 1960). The term stands for Test-
Operate-Test-Exit. The first Test assesses one’s progress toward a specific goal. If the test is not satisfactory, some Operation is engaged in order to correct one’s actions and direct them more closely toward the goal state. Another Test is made to assess whether the goal has been achieved. If not, another self-correcting Operation is tried and the process repeats itself. When the goal has been attained then one can Exit from the loop. In terms of Leonardo’s description, the Test is the comparison of the drawing one has made in the absence of the model with the actual tracing of the model on glass. The Operations have to do with making a number of drawings, focusing on successively more specific areas of discrepancy between one’s free hand drawing of the model and the tracing of the model.

**TEST**

- Fixed Future Goal
- Evidence for Achievement of the Goal
- Flexibility of Means to Accomplish Goals

**OPERATIONS**

The T.O.T.E. Model

It is very important to keep in mind, however, that the goal of the process is not to simply produce an accurate drawing. The accuracy of the drawing is an evidence for the actual goal, which is to internalize a rich cognitive representation of something that you have observed. Leonardo’s strategy involves the process of making successive approximations of a phenomenon in the form of an externalized map. When you can generate a map of an example of something that has come solely from your own nervous system (the drawing done without the model) that matches a map recorded from the sensory experience of an actual example of the phenomenon (the tracing of the model made on glass), it is an evidence that you have some understanding of it; that you “know how to see it” both externally and internally. The phenomenon has become incorporated into your nervous system.

Clearly, Leonardo’s genius and ingenuity as an artist and inventor did not come from simply recording what he observed with the faithful but mindless accuracy of a photograph. By his own declaration, Leonardo was after the “processes of nature’s results” not the “results of nature’s processes.” In other words, he was attempting to understand and represent its ‘deep structure’, not simply record its surface structure. In many ways Leonardo’s drawings of a particular phenomena are much more “real” and alive than a photograph. They capture the deepest essence of the individual or phenomenon. What shines through so brightly from Leonardo’s works, even to the casual observer, is the depth with which he has cognitively internalized and understood what he is representing. He is “demonstrating” that which he has taken into him, not simply recording something which is outside of him.

Borrowing from Aristotle, Leonardo called the mechanism by which these internal cognitive maps were made “the common sense.”

The common sense is that which judges the things given to it by the other senses. And these senses are moved by the objects, and these objects send their images to the five senses by which they are transferred to the organ of perception (impressiva) and from this to the common sense; and from thence being judged they are transmitted to the memory, in which according to their potency they are retained more or less distinctly. (C.A. 90 r. b)

Once enough examples of a phenomenon are “learned well by heart” and cognitively internalized through the kind of method described by Leonardo earlier, they pile up to a kind of 'critical
mass such that the deep structure of the phenomenon as a whole is functionally mapped within one's nervous system ("the common sense"). Then one can begin to experiment with it, predict the effects certain stimuli will produce on it, invent new expressions of it, and represent the results of these explorations on the phenomenon, even in the absence of an existing external model.

For Leonardo, the process of encoding the 'deep structure' of something in one's 'common sense' involved imagination as much as observation and memory. Consider, for instance, the following exercise:

**OF STUDYING AS SOON AS YOU ARE AWAKE OR BEFORE YOU ARE ABOUT TO GO TO SLEEP IN BED IN THE DARK**

_I have proved in my own case that it is of no small benefit on finding oneself in bed in the dark to go over again in the imagination the main outlines of the forms previously studied, or of other noteworthy things conceived by ingenious speculation; and this exercise is entirely to be commended, and it is useful in fixing things in the memory._ (MS. 2038 Bib. Nat. 26 r.)

It is interesting that Leonardo has chosen states of transition between sleep and waking consciousness as the time for this form of 'studying'. According to NLP, and many other psychological models, the physiological state a person is in has a great influence on their cognitive processes. Transition states such as those between sleep and wakefulness afford natural and unique access to subconscious processes. Without the benefits of disciplines such as meditation and hypnosis, it appears that Leonardo intuitively discovered a simple, natural and effective way to tap into and utilize his unconscious processes. In this strategy, Leonardo acknowledges the role that his physical state and the unconscious play in the process of understanding and internalizing something's 'deep structure'.

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**Section 2: Leonardo's 'Cosmography' of the Body**

Leonardo's application of his strategy of using his "common sense" for "knowing how to see" is probably nowhere more evident than in his anatomical work, which he envisaged as a _cosmografia del minor mondo_ ("cosmography of the microcosm").

_Man was called the microcosmos by the ancients, and surely the term was well chosen; for just as man is composed of earth, water, air, and fire, so is the body of the earth. As man has bones as support and framework for flesh, so the earth has rocks as support for the soil; as man carries a lake of blood in which the lungs inflate and deflate in respiration, so the body of the earth has the ocean which waxes and wanes every six hours in a cosmic respiration; as the veins emanate from the lake of the blood and are ramified throughout the human body, in the same way, the ocean fills the body of the earth with an infinity of veins of water._ (A 55v)

In this comment, Leonardo reveals another key element in his strategy—making analogies between the deep structures of two different systems (the earth and a human body). One of the reasons Leonardo was able to cover such a wide range of subjects was because of his ability to recognize similarities between all natural systems at the level of deep structure. These similarities allow one to transfer, through analogy, knowledge that has been learned in one area to a completely different field.
Leonardo's Analogy Between the Earth and the Body

In his opening comments to his anatomical treatise, Leonardo sums up the difference between simple observation and saper vedere, in which one looks for a system's 'deep structure'.

And you, who say that it would be better to watch an anatomist at work than to see these drawings, you would be right, if it were possible to observe all the things which are demonstrated in such drawings in a single figure, in which you, with all your cleverness, will not see nor obtain knowledge of more than some few veins, to obtain a true and perfect knowledge of which I have dissected more than ten human bodies, destroying all the other members, and removing the very minutest particles of flesh by which these veins are surrounded, without causing them to bleed, excepting the insensible bleeding of the capillary veins; and as one single body would not last so long, since it was necessary to proceed with several bodies by degrees, until I came to an end and had a complete knowledge; this I repeated twice, to learn the differences. (Qu. An.II 3r)

Leonardo's stated intention with his work is to synthesize a multiplicity of individual experiences at the dissecting table into each “single figure.” His objective is to map out what he has internalized within his “common sense” as a result of making multiple dissections. He makes it clear that his drawings are to be of the ‘deep structure’ of the body, not merely its ‘surface structure’. In other words, he intends to ‘demonstrate’ what he has learned through a whole group of experiences, not simply to copy down what his eyes recorded in any one moment. He goes on to say:

This depicting of mine of the human body will be as clear to you as if you had the natural man before you; and the reason is that if you wish thoroughly to know the parts of man, anatomically, you — or your eye — require to see it from different aspects, considering it from below and from above and from its sides, turning it about and seeking the origin of each member; and in this way the natural anatomy is sufficient for your comprehension.

Therefore by my drawings every part will be known to you, and all by means of demonstrations from THREE different points of view of each part; for when you have seen a limb from the front, with any muscles, sinews, or veins which take their rise from the opposite side, the same limb will be shown to you in a side view or from behind, exactly as if you had that same limb in your hand and were turning it from side to side until you had acquired a full comprehension of all you wished to know. In the same way there will be put before you THREE or four demonstrations of each limb, from various points of view, so that you will be left with a true complete knowledge of all you wish to learn of the human figure. (Qu. An.II 5v)

Leonardo is clearly equating “comprehension” and “knowledge” of the deeper structure of some phenomenon with having multiple perspectives of it; specifically, “demonstrations from THREE different points of view.” This seems to be a very fundamental and key part of Leonardo's strategy — multiple examples (ten dissections) are synthesized together and represented in multiple perspectives (three points of view). Leonardo is claiming that until one has perceived and mapped something from a minimum of three different perspectives, one does not yet have a basis for understanding it. A “true complete knowledge” comes from the synthesizing of these views into a whole within the ‘common sense’.
Leonardo's comment that one learns about something by "turning it about and seeking the origin of each member," hints of another cognitive strategy in addition to the synthesis of multiple perspectives. Seeking the origin of each member infers that one has divided something into separate elements and is looking for key relationships. That is, that Leonardo is not only looking at the body as a set of things but also as a system made up of relationships. This part of the strategy becomes much clearer as Leonardo describes his master plan for the treatise.

[You will have set before you the cosmography of this lesser world on the same plan as, before me, was adopted by Ptolemy in his cosmography; and so I will afterwards divide them into limbs as he divided the whole world into provinces; then I will speak of the functions of each part in every direction, putting before your eyes a description of the whole form and substance of man, as regards his movements from place to place, by means of his different parts.

There are eleven elementary tissues: Cartilage, bones, nerves, veins, arteries, fascia, ligament and sinews, skin, muscle and fat...First draw the spine of the back; then clothe it by degrees, one after the other, with each of its muscles and put in the nerves and arteries and veins to each muscle by itself and besides these note the vertebrae to which they are attached, which of the intestines come in contact with them and which bones and other organs, etc...

Of the cause of breathing, of the cause of the motion of the heart, of the cause of vomiting, of the cause of the descent of food from the stomach, of the cause of emptying the intestines. Of the cause of swallowing, of the cause of coughing of the cause of yawning, of the cause of sneezing, of the cause of limbs getting asleep. Of the cause of losing sensibility in any limb. Of the cause of tickling. Of the cause of lust and other appetites of the body, of the cause of urine and also of all the natural excretions of the body...

In your anatomy you must represent all the stages of the limbs from man's creation to his death, and then till the death of the bone; and which part of him is first decayed and which is preserved the longest. And the same way of extreme leanness and extreme fatness...

Which is the part in man, which, as he grows fatter, never gains flesh? Or what part which as a man grows lean never falls away with a too perceptible diminution? And among the parts which grow fat which is that which grows...
fattest? Among those which grow lean which is that which grows leanest? In very strong men which are the muscles which are thickest and most prominent? (An. B 21r)

In the terms of Neuro-Linguistic Programming, Leonardo is describing a powerful cognitive strategy for effective systemic thinking. Drawing from his analogy to Ptolemy’s ‘cosmography’ of the earth, Leonardo outlines a program for conducting a visual investigation of the human body guided by language in the form of statements and questions. He is seeking to make as complete of a coverage as possible within a limited number of examples by exploring the interactions of the body’s basic elements within the poles of its extreme conditions: the beginning and the end, the big and the small, etc. He is using multiple perspectives to demonstrate not only structure but the “processes” behind the structure by defining key cycles of growth and change and how those effect the condition of the various elements—defining the interrelations of cause-and-effect and the exceptions to the rule.

On a more fundamental level, Leonardo has laid out a very basic macro strategy for comprehensively describing a system.

1. Define the basic elements of the system - the eleven elementary tissues.

2. Incrementally describe the structural relationship of the elements to one another - draw the spine of the back; then clothe it by degrees, one after the other, with each of its muscles, nerves, arteries, etc.

3. Identify the functional operations of the elements in the system with respect to each other in terms of cause and effect - the cause of breathing, the cause of the motion of the heart, etc.

4. Represent the cycles of change of the elements in the system within the extremes of various key conditions - creation to death, death to decay, lean to fat.

5. Identify the biggest changes within the elements of the system during these cycles and the exceptions to the rule - which grows fattest, which grows leanest, which never grows fat or lean, etc.

Leonardo’s strategy of tracking, either through observation, experimentation or imagination, the way variables change when a system is pushed to extremes, seems to be a profoundly simple yet powerful strategy for understanding the dynamics of a system that has wide implications. By noticing which parts of the system change the most and which parts remain more or less constant during the movement between polar extremes, Leonardo is able to quickly assess deep principles in the functioning and ecology of an interdependent system of elements.
Section 3: ‘Seeing’ Systemically

While Leonardo described and clearly applied this systemic mapping strategy to the human body in his anatomy, he undoubtedly used a very similar process in his other works as well. Because the strategy focuses at the level of 'deep structure', its power, and obviously the power of all of Leonardo's strategies, is that they may be applied in many different contexts. Consider the following description from his treatise on painting:

**OF THE WAY TO FIX IN YOUR MIND THE FORM OF A FACE**

If you desire to acquire facility in keeping in your mind the expression of a face, first learn by heart the various different kinds of heads, eyes, noses, mouths, chins, throats, and also necks and shoulders. Take as an instance noses: they are of ten types; straight, bulbous, hollow, prominent either above or below the center, aquiline, regular, simian, round, and pointed. These divisions hold good as regards profile. Seen from in front, noses are of twelve types; Thick in the middle, thin in the middle, with the tip broad, and narrow at the base, and narrow at the tip, and broad at the base, with nostrils broad or narrow, or high or low, and with the openings either visible or hidden by the tip. And similarly you will find variety in the other features; of which things you ought to make studies from nature and fix them in your mind. Or when you have to draw a face from memory, carry with you a small notebook in which you have noted down such features, and then when you have cast a glance at the face of the person whom you wish to draw you can look privately and see which nose or mouth has a resemblance to it, and make a tiny mark against it in order to recognize it again at home. Of abnormal faces I here say nothing, for they are kept in mind without difficulty.

(MS. 2038 Bib. Nat. 26 v.)

Here Leonardo describes another strategy for developing the “common sense” by connecting external observations to cognitive processes and then using the internalized representations to map the external world. He is suggesting a process, similar to the one he describes in his work on anatomy (and clearly presupposing his earlier strategy for "learning by heart"), involving the categorization of a system into its key elements as visualized from different points of view. This process is called 'chunking' in NLP, and is a very powerful systemic thinking skill.

By forming perceptual filters based on certain key distinctions or typologies of features, Leonardo is able to dramatically reduce the amount of complexity involved in observation and memory. Rather than having to recall and work with thousands of unique faces and expressions, Leonardo suggests working with a more limited set of features by first identifying or “learning by heart the various different kinds of heads, eyes, noses, mouths, chins, throats, and also necks and shoulders.” Once these basic elements have been cognitively internalized from different perspectives, new faces and expressions may then be encoded and classified by associating them with mixes of key features.

While Leonardo left no explicit record of the rest of his classification system other than for noses, we could generalize from his example and make a hypothetical list of features that might look something like the following table. [The check marks indicate one possible grouping of features that could make up a particular person's face.]
Table of Various Facial Features

<table>
<thead>
<tr>
<th>Heads</th>
<th>Noses</th>
<th>Mouths</th>
<th>Chins</th>
<th>Throats</th>
</tr>
</thead>
<tbody>
<tr>
<td>round</td>
<td>straight</td>
<td>wide</td>
<td>square</td>
<td>thick</td>
</tr>
<tr>
<td>egg shaped</td>
<td>bulbous</td>
<td>narrow</td>
<td>pointed</td>
<td>straight</td>
</tr>
<tr>
<td>pear shaped</td>
<td>hollow</td>
<td>full</td>
<td>long</td>
<td>angular</td>
</tr>
<tr>
<td>long</td>
<td>prominent above center</td>
<td>thick</td>
<td>double</td>
<td>long</td>
</tr>
<tr>
<td>prominent in back</td>
<td>prominent below center</td>
<td>thin</td>
<td>jutting</td>
<td>lumpy</td>
</tr>
<tr>
<td>prominent forehead</td>
<td>aquiline</td>
<td>cupid's bow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>simian</td>
<td>round</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pointed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

While the number of items in each category is relatively small, there are 9,000 possible combinations of the features listed. If a face does not fit into one's categorizations then a new distinction might be added, or, as Leonardo infers, kept in mind as an exception to the rule because the abnormal cases are "kept in mind without difficulty".

This kind of systemic exploration of the human face seems to be clearly at the basis of his following comment:

When you have thoroughly learnt perspective, and have fixed in your memory all the various parts and forms of things, you should often amuse yourself when you take a walk for recreation, in watching and taking note of the attitudes and actions of men as they talk and dispute, or laugh or come to blows one with another, both their action and those of the bystanders who either intervene or stand looking (?) at these things; noting these down with rapid strokes in this way, in a little pocket-book, which you ought always to carry with you...for there is such an infinite number of forms and actions of things that the memory is incapable of preserving them, and therefore you should keep those [sketches] as your patterns and teachers.

(MS 2038 Bib. Nat. 26v)

According to one of Leonardo's early biographers (Vasari, 1550), "He delighted much in seeing certain strange heads, with the beard or hair growing wildly, that he would follow about anyone that pleased him for a whole day, so fixing him in his mind that at home he could draw him as if he had him before his eyes."

Incidentally, this chunking processes facilitates innovation and invention as much as it does observation and memory. Once a set of distinctions has been devised to account for the range of experiences one is familiar with, one can generate new possibilities, make forecasts or fill in holes and missing links by anticipating mixes of features that have not yet been encountered. It seems clear that this type of strategy was a cornerstone of Leonardo's creativity.

For example, Leonardo's so-called grotesque heads, which are closely linked with his treatise on painting, have often been described as "caricatures," but actually they are more depictions of 'types of faces' and only occasionally real individuals. Considered in the light of the strategies described by Leonardo, it seems more likely that they are an exploration of the variations of the human face made up of different combinations of features.

Rather than simply record single individuals, it would appear that, similar to his strategy in his work on anatomy, Leonardo's intention was to probe and investigate the gradations within the different mixes of features as one moved between the poles of the various cycles of change for the human face: of the beautiful and the ugly, the normal and the abnormal, the dignified and the vulgar, the old and the young. As Leonardo maintained, "It is the extremities of all things which impart to them grace or lack of grace."
Once our knowledge of a phenomenon has been chunked and internalized, we can explore the richness of its patterns and variations and ultimately release its untapped potentials through imagination. Albert Einstein emphatically maintained that "Imagination is more important than knowledge." And, in fact, Leonardo himself stated that the "faculty of imagination is both rudder and bridle to the senses" and described exercises specifically designed to stimulate and mobilize inner cognitive processes in relationship to visual input. Consider, for example, the following exercise also described in his treatise on painting:

A WAY TO STIMULATE AND AROUSE THE MIND TO VARIOUS INVENTIONS

I will not refrain from setting among these precepts a new device for consideration which, although it may appear trivial and almost ludicrous, is nevertheless of great utility in arousing the mind to various inventions.

And this is that if you look at any walls spotted with various stains or with a mixture of different kinds of stones, if you are about to invent some scene you will be able to see in it a resemblance to various different landscapes adorned with mountains, rivers, rocks, trees, plains, wide valleys, and various groups of hills. You will also be able to see divers combats and figures in quick movement, and strange expressions of faces, and outlandish costumes, and an infinite number of things which you can then reduce into separate and well-conceived forms. With such walls and blends of different stones it comes about as it does with the sound of bells, in whose clanging you may discover every name and word that you can imagine.

(Ms. 2038 Bib. Nat. 22 v.)
As Leonardo himself points out, such seemingly trivial or pointless mental exercises can be quite important. Here he describes a way of cultivating and reinforcing a connection between external visual observations and constructed mental imagery (notated $V \rightarrow V$ in NLP). Like the process of reviewing outlines and forms in the state between being awake and asleep, Leonardo is setting up a way to tap into and direct his unconscious processes. In the model of NLP, such exercises, like the others Leonardo has described, serve to build up a fundamental neurological link which, once established, can become a kind of habitual thinking strategy that may be activated at an unconscious level. In other words, the neurological connection between observation and imagination can generalize and become triggered by stimuli other than a blank wall. If we shift the content of the external-observation-to-internal-fantasy connection of stimulating imagination from looking at walls to, say, watching birds in flight, we can see that this habit of thinking may install a valuable unconscious link between sensory experience and cognitive fantasy that, once trained, could continue to perceive “an infinite number of things which you can then reduce into separate and well-conceived forms.”

This link between experience and fantasy was certainly at the basis of Leonardo's ability to form analogies between different systems; as is evident in Leonardo's observation of the likeness between the movement of water and the movement of hair:

> Observe how the movement of the surface of the water resembles that of hair, which has two movements, one of which stems from the weight of the hair and the other from the waves and curls. In the same way the water has its turbulent curls, a part of which follows the force of the main current, and another obeys the movement of the incidence of reflection. (W 12579r)

It is interesting that, in Leonardo's exercise on stimulating the imagination, he equated the walls with the sound of bells, since probably one of the best examples of the fruits of this kind of exercise is Leonardo's “discovery” that sound traveled in waves. He was standing by a well and noticed a stone hit the water at the same moment that a bell went off in a nearby church tower. He reports:

> The stone where it strikes the surface of the water, causes circles around it which spread until they are lost; and in the same the air, struck by a voice or a noise, also has a circular motion, so he who is nearest hears the best and he who is most distant cannot hear it.” (CA 1041 r.)

This kind of tremendous insight could only happen through a connection between sight and sound made by imagination in the “common sense” - a type of connection that Leonardo intentionally established and fostered through specific mental exercises.

Of course, it was Leonardo's ability to reduce his fantasies into "separate and well-conceived forms" through “learning by heart”, chunking and combining essential features that bridges the gap.
between being merely a dreamer and being a genius and an inventor. Notice how these strategies are explicitly presupposed in Leonardo’s advice on how to construct imaginary creatures.

**HOW TO MAKE AN IMAGINARY ANIMAL APPEAR NATURAL**

You know that you cannot make any animal without it having [features and] limbs such that each bears some resemblance to that of some one of the other animals. If therefore you wish to make one of your imagined animals appear natural — let us suppose it to be a dragon — take for its head that of a mastiff or setter, for its eyes those of a cat, for its ears this of a porcupine, for its nose that of a greyhound, with the eyebrows of a lion the temples of an old cock and the neck of a water-tortoise. (BN 2038 29r)

In this case, Leonardo is clearly using the strategy of identifying, internalizing and combining key features for the purpose of constructing something in imagination as opposed to mapping something input from sensory experience. He is using a strategy quite similar to his studies of the human face in his grotesque characters; cutting and pasting different elements from his memory and imagination to create a natural looking mosaic of features.

<table>
<thead>
<tr>
<th></th>
<th>Head</th>
<th>Eyes</th>
<th>Ears</th>
<th>Nose</th>
<th>Eyebrows</th>
<th>Temples</th>
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<tbody>
<tr>
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<td></td>
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<tr>
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<td>✓</td>
</tr>
</tbody>
</table>

**Table for Creating Imaginary Animals Based on Leonardo’s Strategy**

Apparently it was a strategy Leonardo applied with success throughout his artistic career. For instance, Vasari (1550) reported that when Leonardo was still a youth in apprenticeship (in the workshop of the famous artist Verrocchio), his father, Ser Piero, was given a shield made by one of his peasants. Ser Piero took it to Leonardo in Florence and asked Leonardo to paint something on it. Leonardo “began to think what he might paint on it that would terrify the enemy as did the head of Medusa in ancient times. For this purpose, Leonardo carried to a room which no one entered save himself alone, lizards, newts, crickets, serpents, butterflies, grasshoppers, bats and other strange animals; out of these he formed an ugly monster, horrible and terrifying, which emitted a poisonous breath and turned the air to flame...” When his father came to pick up the shield, Leonardo “exposed the shield on the easel, opened the window so that a bright light fell on it, and then bade his father to come in and see it. Taken by surprise, Ser Piero received a great shock, not realizing that it was the shield or even a painted form that he beheld, and falling back a step, Leonardo checked him, saying, ‘This work serves the end for which it was made; take it, then, and carry it away, since this was the effect it was meant to have.’ This thing appeared to Ser Piero nothing short of a miracle and he praised very greatly the singular ingenuity of Leonardo.”

Leonardo apparently even used a similar strategy to make natural appearing imaginary animals out of real animals. Vasari reports:

On the back of a most strange lizard, found by a vinedresser of the Belvedere, Leonardo attached wings made of scales taken from other lizards, held by quicksilver, which, as the lizard moved, quivered with the motion. He then made it eyes, a horn, and a beard, tamed it and, keeping it in a box, he showed it to his friends to make them flee for fear.
Section 5: Making Machines

One cannot look over the copious mechanical inventions in Leonardo's notebooks without hypothesizing that he must have employed a similar kind of strategy to produce them as well:

1) identifying and internalizing key mechanical elements from existing machines and "natures creations";

2) varying and amplifying certain key features of a machine to see the effects it has on the others;

3) synthesizing new combinations of features and elements; and

4) drawing the results from different perspectives.

As with his other works, it seems that Leonardo's primary motivation for his inventions was to understand the world around him more deeply. In this sense, Leonardo was less an engineer than he was a physicist. Many of his inventions were conceived in order to illustrate the application of mechanical principles rather than simply solve a specific practical problem. Certainly, some of his machines, especially his later ones, were more like experiments in which he was testing the feasibility of their mechanical functioning in order to demonstrate some deeper theoretical principle. For Leonardo it was not sufficient to lay down the invisible laws of nature in abstract formulations. These laws and principles needed to be represented in their tangible appearance and actual operation.
Leonardo's inventions can be categorized into four main types or phases, which illustrate the basic elements of his strategy:

1. Constructions in common use at his time which he studied for special purposes (clock mechanisms, foundry equipment).

2. Constructions which were amplifications of known machines through the applications of combined mechanical principles (the printing press, coin stamp, water mill, textile machines and weapons).

3. Original inventions based on his own theoretical ideas, primarily drawn from his observations of natural phenomena (flying machines, streamlined ships based on the shapes of fish).

4. Experimental devices made to demonstrate fundamental theoretical principles of mechanics (friction devices, transmission gears).

Time and time again we see Leonardo applying the same strategy in his work: 1) identifying key features and elements, 2) cognitively internalizing them, 3) exploring their patterns of systemic interrelationships and functions under various conditions, 4) synthesizing them into new combinations and mixtures of elements and, finally, (5) externally mapping the fruits of cognitive explorations by either (a) holding the elements of the phenomenon constant and changing his perspective or (b) maintaining a particular perspective and varying or amplifying some elements or features of the phenomenon.
Section 6: Making Masterpieces

From his notebooks, it is clear that Leonardo even applied something like this process in the production of his works of art. The Mona Lisa, for example, is probably the most famous and admired portrait in the world, even today. For most people, her universal appeal seems to come from some mystical, unreproducible talent. Sigmund Freud postulated that it was an emotional representation of a repressed memory of his natural mother, from whom he was separated in early childhood. Yet, the following statement from Leonardo's work on painting offers another potential explanation, based on Leonardo's cognitive strategies.

OF THE CHOICE OF BEAUTIFUL FACES

Methinks it is no small grace in a painter to be able to give a pleasing air to his figures, and whoever is not naturally possessed of this grace may acquire it by study, as opportunity offers, in the following manner. Be on the watch to take the best parts of many beautiful faces of which the beauty is established by general repute rather than by your own judgment, for you may readily deceive yourself by selecting such faces as bear a resemblance to your own, since it would often seem that such similarities please us; and if you were ugly you would not select beautiful faces, but would be creating ugly faces like many painters whose types often resemble their master; so therefore choose the beautiful ones as I have said, and fix them in your mind. (Ms. 2038 Bib. Nat.27 r.)

It is intriguing to speculate that perhaps the universal appeal and enigmatic fascination that Leonardo's famous portrait has held for so many people throughout history is a result of Leonardo having succeeded in combining “the best parts of many beautiful faces of which the beauty is established by general repute,” as he himself advised. Perhaps this is why admirers find so many different expressions in the mix of features on the face of the woman in the painting. It is especially interesting to consider this possibility in the light of the fact that there is little agreement about the actual identity of the subject. Even though tradition has it that the model was Mona Lisa, the wife of Francesco del Giocondo, this identification clashed with other observations made of the portrait by Leonardo's contemporaries. Perhaps, then, even the Mona Lisa was one of Leonardo's own ingenious inventions; a composite image of beauty generated from his own nervous system by an intuitive synthesis of the key facial features he had so deeply observed and explored all of his life (Leonardo was in his fifties when he painted it).

Obviously, I do not mean to imply that Leonardo's works of art were merely a result of effective “cutting and pasting” of popularly admired features. Rather, I am proposing that, as with his Anatomy, Leonardo's works were the products of the synthesis of many deeply internalized experiences, expressing the deep principles in the dynamic systems that made up the persons or events he was portraying. In his own words, Leonardo sought to represent the integration of both “physical and spiritual force” in his art. In a manner reminiscent of his anatomical drawings, one of the greatest fascinations of the “Mona Lisa” is the degree to which the features and the symbolic overtones of the person painted achieved such complete synthesis.

* As an interesting side note, a recent study of the painting, which was aided by computer analysis, claimed that the features of the Mona Lisa uncannily matched those of Leonardo himself, especially as a young man, and that it was actually a kind of self portrait. This is an especially interesting hypothesis considering Leonardo's statement that the painter has a tendency to select “such faces as bear a resemblance to your own, since it would often seem that such similarities please us.”
Perhaps this is where some of the properties of the "common sense" again become significant. According to Aristotle, the 'common sense' perceived and processed special qualities of sensory experience that he called "common sensibles". By Aristotle's definition, "Common sensibles are movement, rest, number, figure, magnitude, unity; these are not peculiar to any one sense but are common to all." Typical to his strategy, Leonardo seems to have synthesized all of these qualities together into a deep sense of proportion. For Leonardo, "proportion" was the fundamental virtu spiruituale ("spiritual property"). In the same way that "movement", "rest", "number", "figure", "magnitude" and "unity" were common to all of the senses; "proportion" was common as a "first principle" to all creation. According to Leonardo:

Proportion is not only found in numbers and measurements, but also in sounds, weights, time and position and whatever power there may be. (CU 18r)

In all of his works, Leonardo strove ultimately for "harmony and proportion". Clearly, proportion is not a function of an element in and of itself, but of how elements relate to one another. For Leonardo, one cannot find beauty in individual features. He claimed:

This is what the poet does when he describes a beautiful face feature by feature. This method does not present its beauty to you in a satisfactory manner, because that depends on the divine proportion of all these features together. It is only by their union at one and the same time that they give rise to a harmony that enslaves him who beholds it...[T]he harmonious proportion of painting...is composed of different parts at one time and its sweet accord is at the same time judged both as a whole and in its parts: as a whole from the point of view of the composition, in the details with respect to the intent of the parts which compose the whole. (CU 18r-19r)
According to Leonardo, harmony and proportion are a result of the relationship between the parts of a system and their “intent” with respect to the whole system. True to his beliefs and strategies relating to the development of the “common sense,” Leonardo evaluated balance and proportion based on the dynamic interplay between several different elements.

He also pointed out that the perception of harmony depended on the relationship between the observer, that which he or she was observing and the medium in which the observation was being made.

In all things seen one has to consider three things, namely the position of the eye that sees, the position of the object seen and the position of the light that illuminates this body. (M 80 r)

Balance and proportion were a function of the relationship between these three key factors. In the same way that he developed a “complete understanding” of something by synthesizing it into three different perspectives, Leonardo evaluated his works of art by changing perceptual positions as defined by the relationship between the observer, the object observed and the light illuminating the object.

OF JUDGING YOUR OWN PICTURE

We know well that mistakes are more easily detected in the works of others than in one’s own, and that often times while censoring the small faults of others you will overlook your own great faults...

[When you are painting you should take a flat mirror and often look at your work within it, and it will then be seen in reverse, and will appear to be by the hand of some other master, and you will be better able to judge of its faults than in any other way.

It is also a good plan every now and then to go away and have little relaxation; for then when you come back to the work your judgment will be surer, since to remain constantly at work will cause you to lose the power of judgment.

It is also advisable to go some distance away, because then the work appears smaller, and more of it is taken in at a glance, and a lack of harmony or proportion in the various parts and the colors of the objects is more readily seen. (MS 2038 Bib. Nat. 28r)

Leonardo is implying that there are three important aspects to take into account when we are judging or evaluating something: 1) the point of view of the observer, 2) the state of the observer, 3) the position of the observer in terms of distance. If your perception of your work remains the same even after you:

1. View it in reverse.
2. Change your state and then review it.
3. View it from a distance.

then you know you are approaching something that has transcended the biases of one perceptual position. (I draw portraits myself and constantly use all of the assessment methods that Leonardo has defined.)

Leonardo’s strategy for synthesizing multiple perspectives shows up in another way in his work on the “Leda”. Leda’s legs, hips, lower abdomen, chest and head are all angled in different directions, offering different points of view of the subject, and yet maintaining an overall balance. Leonardo’s Leda became a model of the so called figura serpentinata (“sinuous figure”) — that is, a figure built up from several intertwining views.

Leonardo’s “Last Supper” rivals the fame and popularity of the “Mona Lisa”. It is one of my personal favorites of Leonardo’s works (and indeed of all painting) and I have returned to see it in Milan many times. I have always been impressed by the seamless integration of the technical, aesthetic and symbolic elements within the painting. It has always stood as one my favorite examples of genius in its ability to combine so many different levels of processes together without any of them interfering with the others. No matter what state I am in and no matter how I look...
Strategies of Genius

at the painting it is always appealing and moving. If you defocus your eyes so that you only see the shapes and the layout, it flawlessly matches all of the traditional aesthetic principles. The technical aspects of the representation of the perspective and coloring, etc., are dramatic and well-executed. It is as if all of the principles and strategies that Leonardo has described in his notebooks are present in the work.

But perhaps the most striking thing about the painting is the moment that Leonardo has chosen to represent. Rather than the traditional representations of the "Last Supper" in which Jesus is breaking or blessing bread or wine, Leonardo portrays the moment of highest tension as related in the New Testament when Jesus declares, "One of you which eateth with me will betray me," and the ensuing shock wave it creates on his apostles. The effect is stunning and compelling.

Initially, it would appear as if this choice of subject matter was a once in a lifetime phenomenon, the product of an inspired genius that could never be repeated. Yet, if we consider Leonardo's strategies, we suddenly realize that this is a continuation of the same processes he applied to create his work on anatomy. Given Leonardo's belief that a system reveals its deepest principles when it is being pushed to an extreme, this would be the most logical moment for him to represent. It is as if the apostles are the eleven elementary tissues of the body (Judas who is portrayed as detached and ambiguous is a kind of non-member of the system). Leonardo has clearly internalized them as individual characters, based upon their function in the apostolic community, kinship, attitude toward their master, etc., and is portraying the effect of the extreme condition on the responses of each member of the system.

One can almost see Leonardo composing a matrix of the elements in the system (Apostles, types of reactions, types of situations and conditions, etc.) and experimenting with their variations and combinations until he found just the right configuration.

<table>
<thead>
<tr>
<th>Apostles</th>
<th>Types of Reactions</th>
<th>Types of Situations</th>
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<tr>
<td>James</td>
<td>Guilt</td>
<td>Tension</td>
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<tr>
<td>John</td>
<td>Anger</td>
<td>Calm</td>
</tr>
<tr>
<td>Phillip</td>
<td>Fear</td>
<td>Teaching</td>
</tr>
<tr>
<td>Peter</td>
<td>Confusion</td>
<td>Eating</td>
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<tr>
<td>Matthew</td>
<td>Disbelief</td>
<td>Praying</td>
</tr>
<tr>
<td>Bartholomew</td>
<td>Focus</td>
<td>Healing</td>
</tr>
<tr>
<td>Judas</td>
<td>excitement</td>
<td>etc.</td>
</tr>
<tr>
<td>etc.</td>
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</tbody>
</table>

Hypothetical Table of Apostles and Possible Reactions

Perhaps Leonardo's strategies show up most clearly in the last manifestations of his art. His "Visions of the End of the World" were a series of pictorial sketches that took the end of the world as their theme. Here Leonardo's powerful imagination — born of observation, reason and fantasy — attained its highest level. Leonardo once made the statement, "Nature is full of infinite causes which were never set forth in experience." In his "Visions of the End of the World" the immaterial forces of the cosmos, invisible in themselves appear in the material things they set in motion under this ultimate of extreme conditions.

The framework of the world splits asunder, but even as its destruction occurs, the "monstrously beautiful" forms of the unleashed elements demonstrate the same deep principles of order, harmony and proportion, that presided at its creation and that govern the life and death of every created thing in nature. Leonardo claimed that, "There is no result in nature without a cause; understand the cause and you will have no need of the
experiment." Without any model, these "visions" are the last and most original expressions of Leonardo's strategies in which saper vedere seems to have reached its ultimate expression. Instead of varying the basic elements and features of the microcosms of the human body, the human face, imaginary creatures or machines, Leonardo is varying and amplifying the elements and the features of the cosmos itself. It is as if he has finally succeeded in observing, internalizing, combining, amplifying and representing all of the forces of nature at work at once.

Section 7: Implementing Leonardo's Strategies

What makes someone like Leonardo da Vinci such a special person is not simply the results of his creativity but his process of creativity. The pictures he put in his notebooks were not just images of what he saw in the world around him, but of how he thought about those images around him. The things that he demonstrated to people about how to think creatively were as important as the work that he produced. A lot of people throughout history have produced nice drawings and paintings. Leonardo used his artistic abilities to try to discover things about the deep structure of the world around him and to use those discoveries to enrich that world. He had a set of strategies that allowed him to express his creativity in many different areas. As Leonardo stated at the end of his treatise on painting:

"These rules are intended to help you to a free and good judgment; for good judgment proceeds from good understanding, and good understanding comes from reason trained by good rules, and good rules are the children of sound experience, which is the common mother of all the sciences and arts." (C. A. 221 V. D.)

Diagram of Leonardo's Macro Strategy
In the model of NLP, 'rules', 'understanding' and 'judgment' are supported and linked by underlying cognitive maps, strategies, and skills. In reviewing the material from Leonardo's notebooks we have discovered a set of explicit strategies employed by Leonardo to develop the key cognitive skills necessary to develop good experience, rules, understanding, and judgment by "learning how to see":

2. "Learning something by heart."
3. "Reviewing something in your mind when you are going to sleep or waking up."
4. Fixing a set of features in your mind.
5. Representing something from multiple perspectives.
6. Exploring the dynamic interplay of elements in a system by observing it under extreme conditions.
7. "Stimulating and arousing the mind to various inventions."
9. Synthesizing features to make something beautiful.
10. Evaluating a creation by changing perceptual positions.

In order to develop Leonardo's strategies within our nervous system, it seems only fitting that we should start with "learning how to see." Leonardo claimed that there were "ten attributes of sight, namely darkness, brightness, substance and color, form and place, remoteness and nearness, movement and rest..." One of Leonardo's greatest skills was in being able to see the attributes of things and not just the things themselves. By combining our knowledge of Leonardo's strategies with the technology of NLP we can define some simple yet significant ways to develop Leonardo's abilities within ourselves.

The following exercise is designed to help you enhance your ability to observe and internalize what you see.

1. Find a phenomenon that you can see in your external environment that is either stable or repetitive. Look at it for about 10 seconds.
2. Stop looking at the phenomenon and make a drawing of what you saw.
3. Find a partner and compare your drawings.
4. Take turns asking each other about the internal representation you used to make your drawing; i.e., Is your drawing exactly the same as your internal representation? If not, how are they different?
5. Especially check for any key features of the drawing that seem to be different from the external phenomenon.
6. Referring to the table of "submodalities" provided below, go down the list of VISUAL submodalities with your partner. For each submodality distinction, look at the phenomenon focusing on that particular filter.
**VISUAL Submodalities**

BRIGHTNESS (dim-bright)
SIZE (large-small)
COLOR (black & white-color)
MOVEMENT (fast-slow-still)
DISTANCE (near-far)
FOCUS (clear-fuzzy )
LOCATION

7. Compare your perceptions of where the phenomenon fits along the range of qualities defined by each submodality distinction using a scale of 1 to 10 (e.g., dim =1, bright =10).

8. Explore with your partner what reference point you assumed or presupposed in order to determine the scaling of the submodality distinction. (e.g., “Brighter than what?” “Bright compared with what?” The room? Other objects nearby in the environment? The light outside?)

9. Once again, stop looking at the phenomenon and make a drawing of what you saw.

10. Compare your new drawing with your partner and note what has changed.

11. Explore any changes in the internal representations you used to make your drawings by examining which submodality distinctions had the most impact and influence on your perception (internal cognitive map).

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**Leonardo’s Strategy for Systemic Thinking and Invention**

Throughout this section on Leonardo, we have seen how da Vinci applied the same strategy time and time again. It is a strategy that allows a person to uncover and then work with the ‘deep structure’ of a system. Whether he was examining the human body, studying faces, creating imaginary animals, inventing machines, preparing to paint a portrait, designing a fresco or contemplating the end of the world, Leonardo would continually apply his unique and powerful systemic thinking strategy.

After he had established his criteria for the work, he would explore the deep structure of the system with which he was working by identifying its key elements and features. He would then explore, either through observation or imagination, the interaction of these elements under various conditions—especially the extremes. Following this, he would synthesize this knowledge into particular combinations and configurations which fit with the criteria he had initially established. When he found the right combination, he would draw the result from several points of view.

We can diagram the main elements of this strategy in the form of a feedback loop that we have called a T.O.T.E. In the test phase of the feedback loop, the current state of the idea or work is checked against the criteria that have been established. If the criteria have not been met, the elements are recombined or placed into another configuration and then tested again with respect to the criteria. This loop continues until the criteria have been satisfied. This particular combination is then recorded on paper from different perspectives.
The following steps describe a way in which you can apply the basic steps of Leonardo's strategy for systemic thinking and invention to practically any area of interest. For example, consider a project that you are currently working on. Imagine you are Leonardo da Vinci, a renaissance person of many talents, about to embark upon a new area of scientific or creative work. Get a notebook and a pencil or pen and keep notes on your work as you go through this strategy.

1. **Establish the essential criteria you are trying to achieve.**

   In his anatomical study, Leonardo strove to produce a “true” and “perfect” knowledge of the body that was as “clear” as if you “had the natural man before you.” In his depiction of faces and in his paintings, Leonardo strove to represent “beauty,” “grace” and “proportion.” He strove to make his imaginary animals appear “natural” and to make his machines something of practical value or which would demonstrate mechanical “first principles.”

   Identify the criteria that are important and relevant for your own project. For instance, you may want to have your project be “fun,” “profitable” or “educational.” Your project may also involve certain time constraints or limits of resources that you would want to include as criteria. Write these criteria down in your notebook (or use the space provided below).

2. **Break your project down into a few basic elements and define the key features or conditions of those elements.**

   This process actually involves two substeps. The first is to identify the ‘deep structure’ of the system you are working with. The second step involves defining the key features and variations of those basic elements.

   You may already have a good idea of the key elements relevant to your own project, or it may involve an area or system with which you are unfamiliar. One of Leonardo’s strategies for identifying key elements was by making analogies between the deep structure elements of different systems. In his anatomical work, for instance, he drew a parallel between the cosmography of the earth and the structure of the body. If you are unfamiliar with basic elements that are relevant to your project, you can apply Leonardo’s strategy of analogy by referring to examples of past projects or systems with which you are already familiar. Find the basic elements of the familiar system or past successful project, and then find their analogies in the new project or system. Again you may make sketches or notes in your notebook or use the following table.
As an example, I was once consulting with a man who was a minister. He had been assigned a new project which involved making talks and presentations to different groups of people in his congregation. He needed to design a particular series of evening lectures that would be offered to the church members. This minister had no previous experience in creating such a program. I helped him to identify the basic elements of this project by asking him to think of a past project or system with which he was already familiar. He responded that he enjoyed gardening and that he felt confident and successful while tending his garden. I asked him to define the basic elements involved in successful gardening. After some thought he answered that the basic components were the type of soil one had to work with, the various types of seeds one could plant and the climatic conditions within which one had to work. I then asked him to consider his lecture project and think of it as being similar to gardening. If he were to make an analogy between lecturing and gardening, what would be the ‘soil’, the ‘seeds’ and the various ‘climates’ of a lecture? He determined that the ‘soil’ would be the congregation, the seeds would be the topics or lessons to be covered and the climates would be the types of life situations or challenges that people might need to contend with.

<table>
<thead>
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<th>Systems</th>
<th>Key Elements and Parameters of the System</th>
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<tbody>
<tr>
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<tr>
<td>Gardening</td>
<td>Type of Soil</td>
</tr>
<tr>
<td><strong>New</strong></td>
<td></td>
</tr>
<tr>
<td>Lecturing</td>
<td>Type of People</td>
</tr>
</tbody>
</table>

The next step was to define the key features or variations within those basic elements, just as Leonardo detailed the different types of eyes, noses, chins, etc., in his study of faces. Soil, for instance, might be sandy, rocky, full of clay, etc. The climate may be arid, wet, cold, sunny, etc. Obviously there are many varieties of seeds. I had the minister make lists of the types of people, lessons and life situations that might be relevant to his project. A sample of his answers are shown in the following table.

<table>
<thead>
<tr>
<th>Types of People</th>
<th>Types of Lessons</th>
<th>Types of Life Situations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parents</td>
<td>&quot;Love your neighbor as yourself&quot;</td>
<td>Birth</td>
</tr>
<tr>
<td>Young People</td>
<td>&quot;Ask and you shall receive.&quot;</td>
<td>Death</td>
</tr>
<tr>
<td>Children</td>
<td>&quot;God helps those who help themselves&quot;</td>
<td>Family Crisis</td>
</tr>
<tr>
<td>Other Clergy</td>
<td></td>
<td>Marriage</td>
</tr>
<tr>
<td>Mixed</td>
<td>&quot;Faith the size of a mustard seed can move mountains.&quot;</td>
<td>Illness</td>
</tr>
</tbody>
</table>
In your notebook (or the blank table provided below) make a list of the key features or variations in the basic elements that make up the system or project with which you are working.

3. Choose one feature from each set of basic elements and combine them together.

Just as Leonardo combined the various aspects of real animals to make his fantasy creatures, or synthesized various facial features to make a caricature, or assembled various mechanical parts and principles to make a new machine; choose one feature from each element in your list and synthesize them together in your imagination. In the example of the minister cited above, I asked him to consider various combinations of elements, such as a lecture for young people experiencing a family crisis in which the basic lesson was “love your neighbor as yourself.” Or, a lecture for parents on dealing illness in which the lesson was focused on “faith the size of a mustard seed can move mountains.”

The following are some suggestions, drawn from Leonardo’s strategy, that can be used to help facilitate this process.

a) Randomly put check marks beside a particular group of elements on your lists.

b) Focus your eyes on a wall, the clouds, field of grass, etc. Let your imagination come up with a way to combine the elements.

c) Review the combination of elements before going to sleep or just after awakening.

4. Identify which combination or combinations most satisfy your criteria.

Obviously, not all combinations of elements will satisfy the criteria you initially set, and some combinations may not even be feasible or ecological. When you have made several combinations, check them against your criteria to determine which are the most satisfying and workable. (The minister, for example, chose a half dozen combinations to make up his lecture series. He selected the combinations with which he felt most familiar and comfortable and which would be of most service to the people in his congregation.)

5. Make two or three different maps or description representing your idea or plan.

If your project involves something like a concrete object, you can draw sketches, like Leonardo did when he sketched his machines or drew the parts of the body from different angles. If your project involves something that is more of a process than a thing, you can make diagrams or write a short verbal description or outline. With the minister in my example, I asked him to make an ‘outline’ of the whole series of lectures, sets of lecture ‘notes’ that he might make use of during the lectures themselves and a ‘brief description’ of each lecture that could be printed in the church bulletin.
6. Evaluate your map by considering it from different points of view.

Once you have made your maps or descriptions, it is useful to evaluate them from different perspectives. Leonardo suggested changing one's state and one's visual perspective. You can also take the point of view of various other people that might be involved in the project in some way. For instance, in the case of the minister, I asked him to consider his ideas and plans for his lectures from the perceptual position of someone that might be attending the lecture and of family members of that person. I also encouraged him to consider his plan through the eyes of someone who had been a mentor for him that he considered to be a good speaker. Finally I asked him to consider his plan for his project through the eyes of a gardener. Each perspective brought him new insights and ideas about how he could enrich and improve upon his ideas.

I often use Leonardo's strategy to plan my own seminars. I find it can be valuable to use it in successive stages. First for the 'big chunks' and then for the 'smaller chunks' of my plan. For instance at first I might fill in a matrix for the overall plan for the course; including variations of the type of group, the types of issues to be addressed and the types of tools and techniques I have to offer.

<table>
<thead>
<tr>
<th>System</th>
<th>Key Elements and Parameters of the System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminar</td>
<td>Type of Group</td>
</tr>
</tbody>
</table>

Once I have an idea of the overall plan, I make other matrices to create the types of specific lessons and exercises that I will cover. These would involve a more specific group of elements which take into account the specific topics, time frames and types of activities which could possibly be included in the course.
Da Vinci Creativity Strategy

Make a list of the three basic elements or features you will be combining.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What criteria does your project have to satisfy?

Fill in all of the columns above. Then choose one item from column A, one from column B and one from column C. Make a picture putting them all together in your mind. Then check your idea against the criteria you established in the bottom section. If your idea does not fit all of the conditions you have set, add an item from one of the columns or keep changing the idea until it does fit. If you cannot fit your criteria after three tries, choose another three items from columns A, B, and C.

Conclusion

And as a result of his ability to intertwine observation and knowledge, every phenomenon that could be seen was potentially a means for Leonardo to discover something deeper about the world. In fact, this led Leonardo to take on the monumental mission of attempting to observe all objects in the visible world, discern their form and structure, and pictorially describe them in a "perceptual cosmology" which he embodied in his numerous notebooks (of which 31 survive). As he states in the opening words of his groundbreaking work on anatomy:

> I wish to work miracles; it may be that I shall possess less than other men of more peaceful lives, or than those who want to grow rich in a day. I may live for a long time in great poverty, as always happens, and to all eternity will happen, to alchemists, the would-be creators of gold and silver, and to engineers who would have dead water stir itself into life and perpetual motion, and to those supreme fools, the necromancer and the enchanter.

Obviously, who Leonardo was as a person was unique and the individual aspects of his personality cannot be taught or repeated. The reasons why Leonardo was compelled or inspired to produce his works are also unique to his personal motivations, the values and visions of his time, etc., and cannot (and probably should not) be reproduced. But it is the how of Leonardo's processes that can be comprehended and transferred. For it was through his skills for how to organize and apply his experience of the world that Leonardo released the force of his personality into the world; manifesting his own beliefs and values as well as those of his age. These same processes are still as valuable in today's world as they were in Leonardo's time. Leonardo's world had much less potential than our modern world, and yet look at what he did with it! Imagine if we could release Leonardo's creative thinking skills in today's world. The possibilities are staggering!
Perhaps by teaching more of the "processes of geniuses results" rather than the "results of their processes" to ourselves and to those around us, we can create a modern renaissance of human abilities.

Footnotes to Chapter 2


6. Ibid., p. 23.


9. Ibid., C.A. 147 v.a.