## §1: INTRODUCTION

**Chapter 1:**
**Why we need logic, and what it is**
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*A. The practical imperative of logical thinking*

At the beginning of his very practical book, *Clear Thinking: A Practical Introduction,* Hy Ruchlis relays the following fascinating example. In the early 1960s, military officers monitoring radar at a nuclear base in the Arctic noticed a number of "blips" heading their way. Some thought they were under Soviet Russian attack. Since this was the height of America's "cold war" with the U.S.S.R., it would not have been out of character for the Soviets to launch a sneak attack on a forward American military base. If it was an attack, the commanders of the outpost had to respond with their own nuclear arsenal: it was their job to ensure that any Soviet attack would be met with overwhelming retaliation.

*Picture credit 1: http://commons.wikimedia.org/wiki/File:SPS-67_screen.jpg*

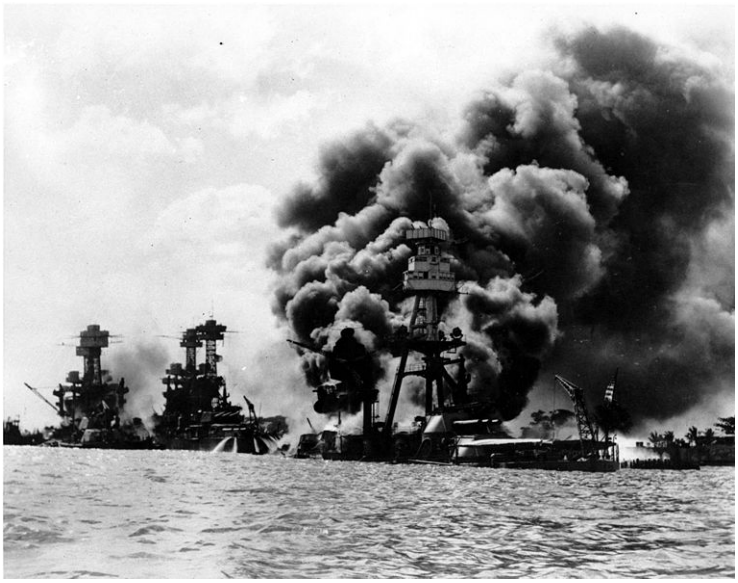
So the base commanders attempted to contact the Pentagon in Washington to verify whether the nation was really under attack. But they couldn't get through. Had Washington already been taken out by a preemptive strike against the capital? If it had been, it was all the more important that the base commanders launch a counterattack. In their view, the Soviets could not be permitted to pulverize the whole nation just because they'd been able to decapitate its leadership. But if the base commanders were wrong and there was simply a glitch in communications—and this wasn't really a Russian nuclear attack—it would be a terrible miscalculation to launch what would then be a first strike against Russia. What were they to do?

Fortunately, one of the officers had his logical wits about him. "Where is Khrushchev?" he asked, referring to the premiere of the Soviet Union at the time. "In New York City, at the United Nations meeting," replied another. Now the wheels of logic began to churn. Why would Khrushchev, an ambitious leader in pursuit of global power, foil his own

plans by launching an attack on the United States on the very day he was visiting the country? Khrushchev would not launch such a strike, these commanders reasoned: *therefore*, however odd the blips on the radar, and however difficult communication with the Pentagon, something other than a nuclear attack must explain the coincidence of problems.

As it turns out, the radar was malfunctioning—reflecting off the moon, of all things—and communication systems with Washington just happened to be malfunctioning that day. Although they did not know this, quick logical thinking enabled them to determine that there was no nuclear attack warranting retaliation. Because of this logical thinking, the base officers successful averted World War III and a global nuclear catastrophe.

Careful, logical thinking is not only needed by those guarding against unnecessary retaliation. Consider another example of a different radar screen, some twenty years prior, on the morning of December 7, 1941. On that morning, Lieutenant Colonel Kermit A. Tyler of the Army Air Corps at Fort Shafter in Oahu, Hawaii, a military installation several miles to the east of Pearl Harbor, was the senior officer responsible for monitoring reports from nearby radar stations.[1] At about 7:15 AM that morning, Lieutenant Tyler received a call from the radar station at Opana, on the north side of the island, reporting "a larger number of planes than [the radar operator] had seen before on his scope." Tyler says he thought about this report for a moment, and replied, "Thanks for calling in the report." He is reported later infamously to have told his station assistants, "Don't worry about it."[2] The blips seen on the radar at this time were, of course, planes in the first wave of the Japanese attack on Pearl Harbor. About a half hour



*Picture credit 2: http://commons.wikimedia.org/wiki/File:Pearl_Harbor_file2.JPG*

[1] For Lieutenant Tyler's own account of the events that morning, see http://www.ibiblio.org/pha/myths/radar/tyler_4.html.

[2] See "Kermit Tyler, Player of a Fateful, if Minor, Role in Pearl Harbor Attack, dies at 96," *New York Times*, February 25, 2010, http://www.nytimes.com/2010/02/26/us/26tyler.html

later, these planes would commence an attack on Hawaii that would kill over 2,400 Americans.

Even if Lieutenant Tyler had known to warn his superiors about the impending attack, there is of course little difference this could have made in the last 30 minutes leading up to the attack. Perhaps more planes could have been mobilized to resist the attack, perhaps more ground personnel could have prepared for the attack, perhaps the Navy could have sought out the Japanese carrier group serving as the base for the attack. There is still much debate about how much foreknowledge American military and intelligence officials had about the Pearl Harbor attacks, and some even claim there was a conspiracy to allow the attack and draw the U.S. into war with Axis powers. Whatever the outcome of that debate, it is interesting to think about what Lieutenant Tyler knew at this time, and whether he could have done anything to give Hawaii an earlier warning.

What was Tyler thinking during the minute before he thanked the radar operator for his report and proceeded to tell his assistants not to worry? Apparently, some advice from a friend, who had told him that "any time the radio stations were playing this Hawaiian music all night, I could be certain that a flight of our bombers was coming over, and when I had gotten up at 4:00 a. m., to report for duty, I listened to this music all the way to the station, so I was looking for a flight of B-17s." Tyler reasoned that if he heard the Hawaiian music on the radio, B-17 bombers would soon be arriving, and when he heard the music, he inferred that these radar blips were indeed friendly planes, not an enemy attack. As it happens, both Tyler and his friends were correct: a group of B-17s was on route to Hawaii that morning. But they would not arrive until later, during the middle of the attack. The bombers were not the only flight arriving that morning.

Could Tyler have known that these radar blips were planes other than the American B-17s? Recall that the radar operators in the arctic thought to make contact with Washington to determine whether there were any corroborating reports of a nuclear attack. But by Tyler's own account, he did not think to ask the radar operators of the number of planes on the radar, nor to contact the Navy about whether the planes were part of a force departing from an American carrier. He also did not think to pass along the report of the unusual radar blips to any further authorities who could verify whether the planes were American bombers. In response to the question, "did you make any effort from any source to find out whether this flight was foreign, or local?", Tyler said that he did not–even though the radar operator had reported such a large group of incoming planes.

To be fair, Tyler as well as the radar operators were new on the job and had not yet been trained to reliably identify or evaluate the blips they saw on the radar. What's more, Tyler claims that he had less reason than usual to expect a Japanese attack that morning: while his station had been on alert the earlier week, news of a diplomatic reconciliation between the U.S. and Japan had been reported in recent newspapers and the alert had been dropped. Still, he could not have missed the news over the years of Japan's unmistakable aggressive intentions in the Pacific, as they had invaded and occupied Chinese Manchuria and French Indochina. If the radar operators in the arctic in the 1960s could have thought to corroborate their judgment about radar blips, it seems Tyler could have just as well. But he did not.

There was not much Tyler could have done at this late stage to prevent the attack, even if he had known to ask the right questions and think about the bigger picture. But his logical error was, in pattern, the same mistake that his superiors made many years earlier when, receiving news of a diplomatic reconciliation with Adolf Hitler in 1938, they decided that Hitler could be appeased and would no longer pose a military threat to the Allies. (We will examine this example in greater detail later in chapter 8.) In both cases, failure to think logically inhibited the victims of looming aggression from preparing to defend themselves.

In the arctic radar example from the 1960s, logical thinking stopped unnecessary retaliation. In the Hawaiian radar example from the 1940s, a failure to think logically inhibited necessary retaliation. In both cases, thinking logically was a matter of life or death. The practical stakes of thinking logically might not always be this high in your daily life, but it is worth considering other, less dramatic ways in which logic affects practical everyday living.

*Picture credit 3: http://commons.wikimedia.org/wiki/File:Apollo_6_launch.jpg*

When it comes to achieving practical results, logic is not just about avoiding disasters. It also helps us achieve positive, productive results. The same technology that enables us to rain destruction on our enemies also enables us to fly to the moon and explore the depths of outer space. Perhaps you think that a journey to the moon was exciting, but can't see how it has affected you personally. But consider that IPhone in your pocket. You can bring up a digital map that pinpoints your exact location on Earth and

navigate your way to new places with very little prior planning—all by way of a system of GPS satellites in orbit around the Earth. Without the space program, we would have none of these. Nor would we have the weather satellites which deliver to your pocket a real-time picture of the planet from space, and by which you can plan what to wear and where to picnic. And it was the logical thinking of generations of scientists that enabled the achievements of the space program—and as a consequence, your IPhone.

We could go into details about the complicated logic of the software programs running on your IPhone. We could talk about the logic involved in constructing electrical circuits. We could talk about the logic by which Newton discovered and justified his theory of universal gravitation, which scientists use to this day to calculate the orbits of the satellites that make our GPS devices tick, and which they use to calculate how much thrust it will take a rocket to get those satellites into orbit. Later in this chapter, we'll consider in some detail just *one* of the crucial assumptions behind the marvel of modern technology in general, and the space program in particular: the knowledge that the Earth these satellites orbit is *spherical*, rather than flat. It turns out that there is a definite logical process by which human beings first came to understand this, well before they were able to look down on the Earth from orbiting satellites above—indeed they needed to be able to do so to get the satellites up in the first place.

But perhaps you are still unimpressed with the practical importance of logical thinking. Not everyone is a military tactician or a scientist, and perhaps while logic is an important tool in their profession, it is not in every field. Consider, again, your IPhone. Scientists and programmers were not the only logical thinkers who helped make it possible. Beyond the raw technology of it, market researchers had to realize the consumer appeal of a device that brought together so many functions in such an elegant package. Accountants had to calculate how much Apple could afford to invest in developing the technology given the expected revenues. And advertising consultants had to conceive of how best to reach you, the targeted consumer, and deliver information about how a device like this could improve your life.

At every level of the productive process, theoretical or applied, human reasoning is the power that has brought us from subsisting in caves to flourishing in a modern industrial civilization. It is the power that we need not only to grow our civilization further, but to preserve it against destruction, both physically and culturally. Logical thinking is at work not only in the clearest of military strategy, but in the best political theory and philosophy. Even artists, conventionally celebrated for their emotional

sensitivity and "intuition," must use a logical process to conceive and execute their masterpieces.

But what exactly *is* a process of logical thinking? There is no way to detail the many examples of logical thinking that contribute to our well-being. The purpose of this book is to illustrate the principles behind logic by outlining the most important *methods* of logics and corresponding *mistakes*, especially on matters of greatest relevance to many students.

Before we reveal the definition of "logic" that we intend to work with in this book, it is worth noting some popular conceptions of what logic is, and evaluations of its relevance.

*Exercises*

1. Think about an important time in your life when you had to make a decision, and you think you made a logical decision. What do you think was logical about it?

## *B. Why we need logic*

If human beings really do stand to benefit from using this tool called logic, there must be a reason for it. There must be something about who we are and the nature of the universe that demands this particular tool.

Consider, for example, why tools are useful, in general. Shovels, hammers, knives, ropes: they're all useful to us because they extend the reach and function of our appendages. We can, if we try, dig a hole in the ground with our bare hands. We can even try to tear things apart by ripping them with our fingernails. But shovels and knives improve our ability to do this dramatically—though we still need our hands to use them, of course. So we need tools because the "tools" we're born with (or hands) have limited abilities, which abilities can be expanded by the assistance of artificial devices well-fitted to our hands.

What is the set of basic "tools" we are born with, whose reach or effectiveness logic helps extend? The answer is our senses. We have a limited number of senses which work in a limited way. We perceive light and sound, for instance. But we only perceive specific frequencies of light and sound: we cannot see ultraviolet and infrared light, nor hear hypersonic dog whistles. Some things are simply too big or too small or too

*Picture credit 4: http://commons.wikimedia.org/wiki/File:The_Earth_seen_from_Apollo_17.png*

distant for us to perceive with our senses. We can perceive neither distant galaxies nor atoms and other subatomic particles with the naked eye. We cannot see the distant past or have clairvoyant visions about the future. Even those things we can perceive with our senses, like the middle-sized ordinary objects in our office, can only be seen from limited aspects. We can only see one side of our desk at a time, not every angle simultaneously as some cubist paintings like to pretend.

Of course a skill like logic does not literally extend the reach of the senses. That is the task of a tool like a telescope or a microscope. But note that even the construction of these tools presupposes a certain logical process. To construct a telescope, an inventor needs to notice that glass has interesting refractive properties and find a way to isolate them by grinding a lens in a specific way. And once the telescope is built, to know that it really does give us a picture of the way things which are far away look up-close, one has to calibrate it. When Galileo turned his telescope to the craters of the moon, how did he know that he was really seeing distant mountains and craters, and not some optical illusion created by the telescope? He reasoned that when he turned the same telescope to distant mountains on the earth, they looked the way he already knew that mountains looked up-close, and so he must be seeing something real even when he looked at objects not previously viewed up close. So, even our interpretation of what we directly perceive through a tool like a telescope is assisted by a kind of logical inference.

More generally, *all* logical inferences assist us in "seeing" facts distant from our perceptual awareness. Consider that presupposition of the space program which I mentioned earlier: the belief that the Earth is spherical rather than flat. How did scientists know this before they launched satellites into outer space? Consider that the only aspect of the Earth human beings could see directly for millennia was the flat stretch of the land stretching out in front of them. Had any men of millennia ago been whisked into space by benevolent aliens, they *could* have seen directly the curvature of the Earth, or even the whole globe. But to be able to launch real astronauts into space today, we've got to know already that the Earth is a sphere. There were, in fact, logical arguments available even to the ancients which permitted them to

***Picture credit 5: http://www.flickr.com/photos/question_everything/3983683159/***

draw the logical *inference* that the Earth was shaped like a sphere, even though they could not see this directly. Like all informative inferences, it was based on things that they could see directly.

The first reason we need logic, then, is that *logic allows us to know things about the unperceived on the basis of evidence we can perceive.* In this way, logic is like a telescope, but opens up a universe of facts that even telescopes cannot reach. But why do we need something like *logic* to let us do this?

*Picture credit 6: http://commons.wikimedia.org/wiki/File:Hereford_Mappa_Mundi_1300.jpg*

Of course logic does not *literally* let us see things we otherwise couldn't see, as a telescope does. The ancient Greeks *knew* that the Earth was round, but they had no way of imagining the blue-green wonder that we saw when the Apollo astronauts first took a picture of the whole of it. The Greeks could only "see" with their mind, i.e., they possessed a *conceptual* rather than a *perceptual* awareness of this fact. They were able to form a higher-level *judgment* that the Earth was round, even if they could not see its roundness. The fact that we possess the faculty of judgment is a great distinction that enables us to project the unseen, but it is also dangerous in a way, because we can use the same capacity to project things that are *unreal*. The possibility of error exists for any other judgment we might make about the universe. We may see the relatively flat Earth around us and conclude that the Earth as a whole is flat. This would be a projection beyond what we can see, but in this case, a false one. Or we might get the shape of the Earth right, as the ancient Greeks did, but get its position in the universe wrong, thinking that it is at the center of the universe, and that the planets, the sun, and all of the stars orbit around it. Our ability to arrive at a multiplicity of conclusions about the unseen is great promise but also has the potential for great peril.

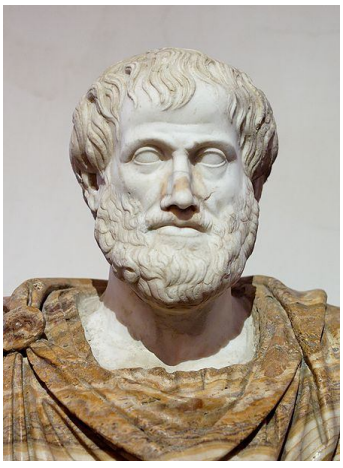
*Picture credit 7: http://commons.wikimedia.org/wiki/File:Armillary_sphere.png*

Some philosophers have said that our senses, like our judgment, can be deceived. The more you think about it, the less convincing this sounds:

when you see a stick in water that looks bent, it is certainly an unusual way of seeing a stick, but our senses are not "censoring" information from us. In fact they are giving us important raw data: what we need to understand that the stick is in a medium through which light travels at a different rate, for instance. The error comes when we make a conceptual-level *judgment* that the stick is bent, when we assent to that proposition using our mind. Then it is *we*, not our senses, who are in error.

Here, then, is the second fact about human cognition that makes logic necessary. Because the limited information we receive from our senses is compatible with a great number of different judgments or beliefs, and because sensory appearances can sometimes be misleading, we need logic because *we need a step-by-step method of piecing together this perceptual information in the right way to see the bigger conceptual picture, the whole truth*. In this way, logic is a lot like a ladder which, if we climb carefully and high enough, allows us to see further than we would by standing on the ground.

It is worth considering briefly how the ancient Greeks were able to piece together the evidence they could directly observe in order to come to a conclusion about the shape of the Earth as a whole. You might wonder why it's worth asking the question about the Greeks. Well, how do *we* know that the Earth is (roughly) a sphere? The fact that we have pictures from outer space is pretty convincing, but we would not have these unless someone knew enough about the Earth to venture into space in the first place. You might say that before the space program, we had plenty of evidence concerning the Earth's shape based on the frequent circumnavigation of the globe. Magellan was the first to do it between 1519 and 1522. But why was *he* confident that he could sail around the world? The answer turns out to be the same as what made Columbus confident enough to venture into the Western sea.



*Picture credit 8: http://commons.wikimedia.org/wiki/File:Aristotle_Altemps_Inv8575.jpg*

It is a longstanding historical myth that the leaders of the Age of Exploration thought that they might sail off the edge of the Earth, and that it was only a bold "leap of faith" across the ocean that proved otherwise. In fact Columbus *knew* that the Earth was a sphere (even if his sailors did not), and he is thought to have been bolstered in his knowledge by reading the following paragraph in Aristotle's treatise, *De Caelo* (*On the Heavens)* about how one could sail from the Atlantic ("the

Pillars of Hercules") to India:

> Hence one should not be too sure of the incredibility of the view of those who conceive that there is continuity between the parts about the pillars of Hercules and the parts about India, and that in this way the ocean is one.

Columbus, like many of his contemporaries, was relying on ancient wisdom, wisdom that had been abandoned earlier by many medieval scholars, who instead took the Bible's account of a flat earth on faith. But how did the ancients know better?

The bulk of the ancient evidence is found right there in Aristotle's treatise. The first observation he refers to is not even an observation about the Earth itself, but about the moon. What do we observe during an eclipse of the moon? We see the *circular* edge of the Earth's shadow move across the moon, engulf it entirely, and then we see the opposite circular edge of the shadow, until the shadow disappears and the moon is once again in the light of the sun. Now this evidence could be taken by itself to suggest that the Earth is just a flat but circular disk. But then it would be next to miraculous that every eclipse looked the same way, and that we never see an eclipse involving flat-as-a-pancake shadows. Only a sphere produces a circular shadow under any projection. Notice that the observation of the circular eclipse itself requires step-by-step interpretation: the reasoner must consider all of the possible shapes that could project such a shape, and rule out those that do not explain what is seen consistently, until only one possibility is left.

*Picture credit 9: http://www.flickr.com/photos/aresauburnphotos/2280484803/*

Aristotle also reported that as we move from one latitude to another, the patterns of the stars we observe change. Some stars seen in Egypt, he says, cannot be seen further to the north at all. This is a familiar observation today. Look at the flag of Australia: it has a constellation called the Southern Cross, which can never be seen from the Northern hemisphere. This observation is easily explained by the fact that the Earth is a sphere. Since the edge of a sphere is curved, a star in the distance might be beneath the viewer's horizon at one latitude, but not at another. Using this simple geometric fact, together with some more impressive trigonometry, the

ancient Greek astronomer Eratosthenes was actually able to calculate the *size* of the Earth to an amazing degree of accuracy (somewhere between 1% and 16% error, depending on how we interpret his ancient units of distance). Other Greeks used the same observations and calculations to calculate, again with great accuracy, the size of the moon, the distance to the moon, and even the distance to the sun. The Greeks may not have been able to explore the universe with space ships, but using logic, they were able to explore it with their minds. As before, notice that a single observation or two will not interpret itself: one has to observe the sky from a series of different places, recall how the different observations vary continuously, and conceptualize the geometry that would account for this variation.

*Picture credit 10: http://www.nasaimages.org/luna/servlet/detail/NVA2~4~4~6554~107080:Star-Trails-at-Dawn; http://commons.wikimedia.org/wiki/File:Steve_Ryan_-_Stars_around_Polaris_-_Day_62_%28by-sa%29.jpg*

A third piece of evidence not cited by Aristotle was nonetheless available to early explorers like Columbus, especially those who would have had access to telescopes. If the Earth were flat, only a tiny elevation above its flattest regions would enable us to see to its furthest edges. But we cannot do this. Instead we see ships disappearing over the horizon at sea. As before, this observation does not automatically give us knowledge of the Earth's shape. One might account for the observation because of atmospheric effects. Perhaps it gets to hazy to see very far at a certain distance. But atmospheric effects would not account for the curious

*Picture credit 11: http://commons.wikimedia.org/wiki/File:Shiphorp.jpg*

phenomenon of being able to see the *masts* of the ships peak over the horizon before the rest of the ships follow. This observation can be accounted for only by supposing that the surface of the Earth is curved.

There are a great many other examples we could use to illustrate the power of a step-by-step method of gathering evidence to reveal to us the wider workings or innermost secrets of the universe, but none are more dramatic, at least to this author, than the way these relatively simple observations literally opened up our world for exploration.

There is one more fact about the human mind, apart from the limitations of the senses and the open-endedness of our judgments, which is crucial to understanding why we need logic. Part of what makes human beings distinctive is their cognitive *freedom*: we can choose to gather evidence or not, and choose to *use* the evidence we gather or not. There are many ways we can fail to integrate the needed evidence, and many different motives for failing to do so. We might be mentally lazy, for instance. We might see that the Earth looks flat around here, and *literally* not be interested in what lies "beyond our horizons." Or, we might be mentally evasive, and seek to suppress our awareness of evidence beyond those horizons. This second option is the only way to explain the temporary medieval European abandonment of the Greek theory of a spherical Earth. Medieval Europeans wanted to believe the picture of the world according to a literal Biblical interpretation, which in various places implied that the Earth was a flat disk with a dome of the heavens or "firmament" covering it overhead. They believed this in spite of possessing the easily accessible evidence the Greeks had summarized for them.

The third fact about human beings that explains our need for logic, then, is that in an important sense, we operate our minds by choice. We can choose to lower our level of awareness, for instance, by either drifting lazily or actively seeking to rationalize our wishful thinking.[3] Because of this fact about us, *we need the method of logic to guide our choices in favor of those which respect our evidence.* Logic is not just like an instrument that helps us see farther, but like a compass that *reminds* us where to look. It is like a "moral compass" for our mind.

There is one last but crucially important fact that underpins our need for logic. So far I have presented three facts about human beings and their minds: our senses our limited, our beliefs can conceptualize the universe in different ways, and we can choose to use our minds well or poorly. But these are just the facts about *us*. Also of importance are facts about the *world*, and

[3] For more on what it means to operate our minds by choice, see my essay with Greg Salmieri, "How We Choose Our Beliefs," <http://www.benbayer.com/how-we-choose-our-beliefs.pdf>.

one crucial fact in particular. It is actually a fact that everyone recognizes, whether or not they always admit it: facts in the world are *not contradictory*. No one would claim, for instance, that Earth is both a sphere *and* flat, or that it is both a sphere *and* not a sphere. It is either one or the other, it cannot be both. Commenting on this, the *law of non-contradiction*, Aristotle remarked that anyone who denied this most basic of the laws of logic could not be said to be thinking at all, and would be "no better than a vegetable."

Now, most human beings have no problem avoiding contradictions like "The earth is a sphere and it is not a sphere." These contradictions are too obvious for anyone to miss. But notice that for a long time, astronomers believed *these* two propositions: "All planets are spherical," and "The earth is not a sphere." The trouble is that it turns out that the Earth *is* a planet, which makes these propositions contradictory. Only astronomers did not realize that they were committing a contradiction by implication, because they did not recognize that the Earth is a planet. Usually the contradictions that bedevil our thinking are of this variety, contradictions that crop up by implication, because we cannot see important links between items of our knowledge.

It is for this reason that the science of logic not only counsels us to pay attention to our evidence, but to work to actively integrate our evidence. The fourth and final reason we need logic, then, is that *we need a step-by-step method which guides us against a basic error: contradiction*. In this way, the tool of logic is like any other tool we use: it is fitted not only to the nature of the tool user, but to the nature of the objects on which the tool operates. A shovel must be rigid to scoop the earth; a knife must be sharp to ply apart softer material. Likewise, logic must counsel us to avoid contradictions in our thinking, if the object of our thinking is to know reality—reality is not contradictory.

### *C. Logic defined*

Having surveyed the facts about us and the world that give rise to our need for logic, we now have a better idea of the *purpose* served by logic. We have said that logic serves many practical purposes, but it does so in virtue of its serving a special cognitive purpose. In order to achieve practical success with logic, we need to know the world around us. And in order to know the world around us, we need a method of cognition of the kind we have described.

Knowing the purpose of logic, we are now in a better position to formulate a preliminary definition of the concept. We often define the nature of our tools by the nature of their purpose. We define a shovel as a tool for

digging, a knife as a tool for cutting, etc. Logic is a tool for knowing reality, but a very special kind of tool for doing so. Our senses give us a kind of basic, automatic knowledge of the world, but logic gives us more than that. *Logic is the science of the method of non-contradictory inference*.

By now you should see how each of the reasons for which we need logic play into this definition. The fact that our senses are limited means that we need to use *inference*. The fact that we can form many different beliefs about the same reality means we need a *method* for forming our beliefs. The fact that we can use a method poorly means that we need *guidance* in its use. And the fact that the world cannot be contradictory (but our beliefs can) means that our method must counsel against forming contradictory beliefs.

Hopefully, this very brief sketch of what logic is and why we need it should motivate you to carefully reconsider the stereotypes about logic we are about to discuss. So far from being impractical in the affairs of the world, the dedication to logic has been responsible for some of the greatest glories of human civilization. We should all be able to appreciate the emotional significance of that.

*Exercises:*

1. Think of an example of a logical inference made in a field that interests you. Briefly state the kind of observable evidence it relies upon, and the conclusion about the unobserved that it helps to produce.
2. Think of an example in which different people (either at the same time, or over time) developed competing views or theories about the same topic. It would be especially interesting to state an example in which having more evidence allowed for the development of a different theory.
3. Give an example of a person you know (keep it anonymous to protect their privacy!) formed a judgment in a mentally lazy or evasive manner. What was the conclusion they came to? What evidence were they ignoring?

## *D. Stereotypes about logic, and why they are misconceptions*

What do you think of when you hear another person described as "logical"? Some people think, "This person must be stuffy and not much fun"? Perhaps some apparently logical people really are that way. Surely many of us have known a least a few of these types. But are all logical people really this way?

Why think of logic as "stuffy"? Some think of logic as they do of chess, as a technical game to be played, sometimes just to best another in competition. There *are* some similarities between logic and chess. Both involve careful thinking in accordance with rigorous rules. And chess *is* just a game. Its rules are basically made up. There's nothing about reality that requires that things shaped like knights have to move in the pattern of an "L." Real knights probably moved in many other patterns. When someone says that chess is "just a game," they mean that the object of the game, and the rules that describe how we are to obtain that object, don't reflect anything in real life. In real life, real knights don't move in an "L" pattern, and *we* aren't real knights. We don't do battle with kings and queens and pawns. Chess is just a game, because the object of taking out the enemy king is a pretend goal that we adopt in order to entertain ourselves.

Logic and chess do have some similarities. Does it follow that logic is just a game? According to one stereotype, logic deals with strange symbols and rules that stand in an arbitrary relationship to the world in the same way that the knight in chess does.

Consider an example of a piece of apparent logic that looks like an elaborate game. The philosopher Zeno once gave what looked like a logical argument proving that we could never move across the room. To get across the room, we need to first cross half the distance; to get half the distance, we need to go half *that* distance; and so on…the process involves an infinity of steps, and we can't take an infinite number of steps! But we all know that we can move across a room, so this argument looks like an elaborate parlor trick. Presumably Zeno knew this as well, since he thought he could move his stylus across the parchment to write out his argument.

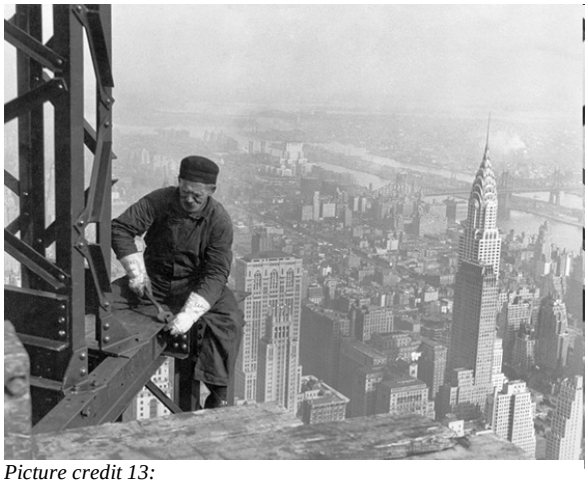
*Picture credit 12: commons.wikimedia.org/wiki/File:Rembrandt_Philosopher_in_Meditation.jpg*

Perhaps it's true that some arguments that *look* logical are like games. But is everything that looks logical *really* logical? Learning logic helps us to be on guard against logical *fallacies*—superficially plausible but ultimately erroneous inferences that people commonly rely upon. Fallacies, in fact, are part of what gives logic a bad name: when philosophers try to demonstrate

fantastic conclusions using what appears to be logic, you can bet that their argument probably isn't *really* logical. Just as a parlor trick performed by a magician employs "sleight of hand," normal physical movements so quick that, to the eye, they appear to involve miraculous powers, arguments that lead to paradoxical or absurd conclusions have to involve some kind of subtle illogic. The illogical argument involves some erroneous assumption, or moves from its assumptions to the conclusion in an erroneous way, or ignores relevant additional facts which, if considered, would lead to a different conclusion.

One of the most directly practical uses of logic is the detection of fallacies in other peoples' arguments. While we will, from time to time, look at the results of famous scientific discoveries and experiments, we do not need to study the most dramatic uses of logic to appreciate how even non-scientists can use logic to our benefit in everyday practical affairs. We don't need to be rocket scientists to use logic in intellectual self-defense against those hucksters and demagogues who attempt to foist illogical arguments on normally unsuspecting ears. We will spend a fair amount of time trying to catalogue and understand logical fallacies like these in this text, but we will always do so by first contrasting them with examples of solid reasoning.[4]

One question for those who consider logic to be a game detached from reality is: How could such a game have so many practical results, of the kind considered in the first section? And how could the discipline of logic be so practical unless it had some bearing on facts in the world? Logic can be likened to a refined version of "common sense." Nobody would consider common sense to be unrealistic, and logic is simply the norms and practices of ordinary reasoning, held up to a critical light and examined in

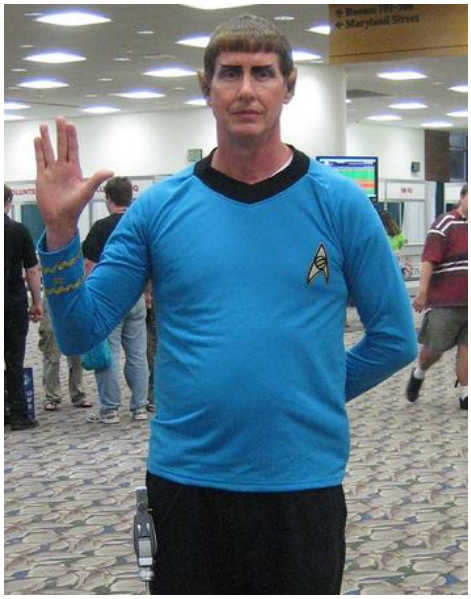


*Picture credit 13: http://commons.wikimedia.org/wiki/File:Old_timer_structural_worker2.jpg*

[4] The lesson to take away from learning about the fallacies is not that people are easily duped and that you might use the fallacies to dupe them yourself! It is that logical arguments can be separated from illogical ones, so logical ones are at least possible, and just as you would not want a shyster to use fallacies against you, you yourself should aim to argue clearly and logically to others, as well.

closer detail, with an eye to improving it by making it more consistent. Logicians study reasoning processes used by ordinary people, and *why* some of these processes work, while others do not. [5]

Another stereotype holds that logic is somehow alienated from human nature, because it is somehow opposed to emotion. It's thought that when people think logically, they must act in a completely unemotional manner, and that emotional people are thereby irrational. The ultimate representative of this viewpoint is Spock from *Star Trek*. Mr. Spock is the ruthlessly logical Vulcan who does not understand the motives of his human comrades, or know how to relate them because of an inability to empathize. Captain Kirk, by contrast, is passionate—seducing many an alien woman in many a space port—and he cannot understand Spock's obsession with calculating the probabilities and risks involved in important decisions. He adheres to the "act first, think later" philosophy, and often his gambles pay off. Many think that if we were like Spock and simply crunched numbers all day, not only would we never get anything done, but we'd never be able to relate to other people or be happy.



*Picture credit 14: http://www.flickr.com/photos/unforth/2821996848/*

The view that logic and emotion are opposed to each other is driven home by the assumption that emotions are *passions*, that is, that we are the *passive* recipients of these emotions, rather than *active* causes of them. Emotions simply filter through us like wind through the grass. And it's thought that we can either bend with this wind, or stand rigidly and risk breaking. It's thought that too much logic will cause us to repress our emotions, and bottling up a force like this will only lead to an explosion later on. Psychologists have certainly learned much about why it's a bad idea to bottle up our emotions. But is it true that being logical

[5] There is much debate among philosophers about just precisely how logic relates to the world. Does it do so because it helps us discover real causal connections between facts, for instance, or does it help us simply because it helps invest our decisions with a high degree of probability, by which we can make rational bets? Does it deliver practical results because it accurately predicts the behavior of really existing unobservable properties in the world, or does it merely serve the task of calculating the play of different experiences before our minds? Whatever the answers to these questions and however it is that philosophers understand the "reality" these questions concern, it is obvious, at least to *this* philosopher, that there is a world independent of our minds which logic must have *some* way of latching onto.

necessarily involves bottling up our emotions? Is it true that to be logical, we must all be like Spock?

Consider again the base commanders at the arctic nuclear missile base. They are certainly *frightened* by the possibility of a nuclear war, and *desire* to avoid it at just about any cost. They use logic to achieve this desire and alleviate their fear. When they realized that their reasoning had paid off, they also must have been elated. We might describe their decision making process as a "passionate search for dispassionate truth," as one philosopher once described the practice of logic more generally. These base commanders did not let their passions cloud their judgment. They did not become so frightened of the possibility of a nuclear attack that they never stopped to consider the other possibility, that none was occurring. And so when they made the delicate connections of logic themselves, they did not allow their emotions to sway their judgment. But the need to make this logical judgment was still *motivated* by ordinary human concerns: to avoid the worst possible outcome, the officers needed to know the *truth* of the situation. So there is a straightforward way in which reason serves emotion—by providing it with objective data needed to accomplish a desired end—and there is a way in which emotion serves reason—by motivating it to inquire when it is needed most.

But there is an even deeper affinity between reason and emotion that we will explore in greater detail later in chapter 6. It is not simply that we have various emotional motivations, and use reason to satisfy them. There are ways we can use reason to *evaluate* those emotions themselves. This is a point that is taken very seriously by contemporary cognitive therapists. Since the late 20th century, these therapists have realized that many of our most chronic psychological problems—depression, anxiety, phobias—are the result of various entrenched *thinking* problems. Though it is no easy task to solve these entrenched problems, asking enough questions about our basic but often hidden premises about what is good and bad, about what is important or not in our lives can yield answers, and when we are able to subject or hidden premises to the light of day and evaluate them, we can at least begin to change our overall psychology, including the way we respond to life

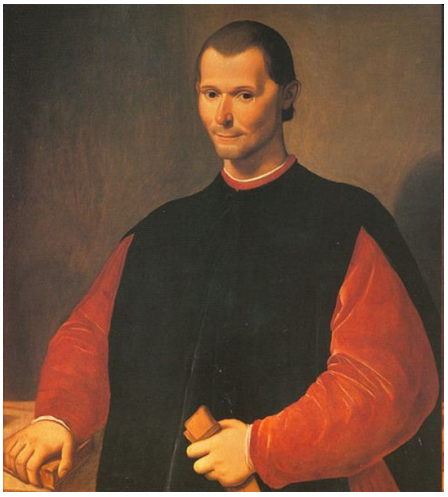
*Picture credit 15: http://www.flickr.com/photos/jerry7171/17519669/*

emotionally. It seems that our emotions are relics of our older thinking, and if there are emotions that bother us, it may be because our older thinking has not been integrated well with our newer thinking. If this is true, then reason not only cooperates with but *molds* our very emotions, enabling us to live confidently and harmoniously with our emotions. It turns out that understanding where emotions come from can help us understand why it is improper to rely on an emotion as if it were a new source of thinking, which some people (maybe even Captain Kirk) too often do.

A third, related stereotype is that logic is useless when it comes to dealing with other people, because many people are irrational. We may have the best argument in the world, but if another person doesn't "listen to reason," we have no influence over their thinking and acting. Sometimes logical people speak of having "knock-down" logical arguments for or against various propositions. But we all know that no argument has ever knocked anyone down.

Does logic need to *force* others to change their minds to be useful for dealing with them? Of course some people allow themselves to believe fallacies, rather than good logical arguments. But when you know the difference between logic and illogic, at least some of the time you can point this out to people, and explain why their beliefs do not hold together sensibly. If they still don't listen, you can at least work to understand where their reasoning went wrong, what mistaken premises might be motivating their emotionalistic reaction, and be on guard against similar reasoning of your own. Logic may not give us a way of "knocking down" other people, but it will at least help us stop them from knocking *us* down, and in a few rare cases, it may help us gently nudge the other person to stop trying to knock us down.

A final stereotype about logic holds that in addition to not helping us deal constructively with other people, logic can assist us in manipulating or exploiting them. This is the origin of the expression "criminal logic." It's thought that the criminal who concocts the most devious scheme to dupe or bilk his fellow men for their riches is acting in a perfectly rational way. His arguments might not knock down the other person, but his scheming might knock down the other person's safe. Monty Burns from *The Simpsons*, Dr. Strangelove from the film of the same name, even Henry Kissinger from politics of the last century (in some people's views)—each is thought to be an "evil genius" with a grand scheme to plunder the masses, construct a doomsday device, or rule the world. All are thought to follow the "logic" of Machiavelli, the Renaissance political theorist who counseled the politicians of his day to find the most practical scheme to maintain their power—



*Picture credit 17: http://www.flickr.com/photos/unforth/2821996848/*

whether or not it involved the exploitation or oppression of innocent citizens.

There is a sense in which one can be "logical" in calculating the best means to an end—regardless of what that end might be. But does logic have nothing to say to us about those ends themselves? And is it logical to manipulate and exploit other people to achieve one's own ends? We have just spoken briefly about how logic might be used to evaluate a given person's emotional motivation. But consider also that one of the most devious forms of manipulation of others is the issue of *illogical* arguments. The huckster and demagogue rely on *fallacies*, not scientific analysis, to sway the masses. We have already emphasized how logic can be practical to one's own life. By the same token, we ought to encourage other people to use logic, too; when they are left free from manipulation they produce rockets and satellites and GPS and IPhones, which they can trade with us to mutual benefit. So if we can benefit from others rationality in this way, why should we suppose that by duping other people—by depending on their *irrationality*—we will somehow prosper in the long run? Fly-by-night hucksters and demagogues all too often find that in the long run, you can't fool all of the people all of the time. Dealing with other people rationally, however, allows us to benefit from the best in other people, not hang perilously on their worst.

*Picture credit 16: http://commons.wikimedia.org/wiki/File:Sonsbeck_-_Ferkelmarktbrunnen_03_ies.jpg*

*Exercises*

1. Can you think of an example of a case where a logical argument seems like a game? Or when it seems to be detached from reality?
2. Consider the example of Zeno's argument for the impossibility of motion. Do you think it is a *good* argument? If it isn't one, how would this effect your evaluation of logic?

3. Think about the contention that we can't use logic to deal with irrational people. Can you give an example of such a person? Is it true that such a person would *never* listen to reason? What are the kinds of things he'd be least likely to listen to reason about? The most likely?
4. Suppose that Spock knew that if he sat around calculating risks all day, he would run the risk of never accomplishing anything. Would it be logical for him to keep calculating?
5. Can you give an example of an emotion that you think is irrational? Why do you think it is irrational? Are there no circumstances under which it might be a good thing to feel?
6. Can you think of an example in which you think you may have been mislead by a salesman or a politician into believing something that wasn't true? What tricks of reasoning did he or she use?
7. Do you agree that it is never good to encourage another person's irrationality? Why or why not? Can you think of an example in which you have benefited from another's sloppy thinking? Why do you think it was really a benefit, as opposed to a short-term thrill?