Does scientific theory change need to be rational? If it is not, if science were truly an “irrational monster,” as critics of Kuhnian philosophy put it, then we would have no metric to decide which scientific theories are preferrable to others. Why does it matter which scientific theories are more preferrable than others? Because the quality of our lives depends on science. Every single technology we use (lights, computers, cars, etc.) exists partly due to the success of certain scientific theories over others. Engineers create technology based on the best scientific principles they can find.

Consider this: the Tacoma Narrows Bridge collapsed in 1940 because the engineers did not understand aerodynamics completely. It was destroyed by strong winds that created more torsional force than its structures could handle. Since then, engineers have considered torsional forces in their designs. The theory of torsional forces has not been rejected and bridges built with this theory in mind continue to withstand strong winds. So, knowing which scientific theories are more preferrable than others can be the key to saving lives. The philosopher Thomas Kuhn argued that scientific theory change is the replacing of past paradigms with new ones. Larry Laudan, on the other hand, argued that scientific theory change can happen in a piecemeal fashion, which he called the reticulated model. In this essay, I will argue that Laudan’s reticulated model improves upon Kuhn’s paradigm model, in which scientific theory change cannot be measured rationally.

First, let us understand the Kuhnian model I am refuting. According to Kuhn, every scientific theory exists within a paradigm, which is a set of theories, methodologies, and values. An example of a Kuhnian paradigm is Newtonian mechanics. You have the theories, such as Newton’s laws of physics; the methodology, which includes the experiments run to test the theories; and the values, which are the overall goals for the paradigm. For Newtonian mechanics, the values may be things like “to explain why objects move the way they do” or “to better understand the physical laws of our reality.” If the theory is disproven by the methods or fails to apply or attain the values of the paradigm, the paradigm may collapse. But if the theories continue to withstand the methods and apply the values, then the paradigm is healthy and may exist for a long time.

An important thing to note when understanding Kuhn’s paradigm model is that a paradigm cannot be disproven by other paradigms. In *The Nature and Necessity of Scientific Revolutions,* Kuhn explains that Newton’s mechanics were not disproved by relativistic physics (p. 91), which is widely considered to be a more accurate model of physics. Instead, both paradigms continue to exist, and Newton’s mechanics are still widely used by engineers and sometimes used by physicists. So, how does scientific theory change occur within the Kuhnian model? Paradigm A must be destroyed before Paradigm B can be adopted, because Paradigm B probably rejects Paradigm A if it is truly a better paradigm. If it isn’t, then they can both coexist as Newtonian and relativistic physics do.

But how do we know which paradigms are “better” than others? Kuhn’s response: “…paradigm choice can never be unequivocally settled by logic and experiment alone” (*The Nature and Necessity of Scientific Revolutions,* 88). In other words, paradigm change is not an entirely rational process. This is a direct result of the fact that Kuhnian paradigms exist independently of each other, such that Paradigm A has nothing (no theories, methodologies, or values) in common with Paradigm B. Given this, there is no way to commeasure these two paradigms against each other to see which one is better. Again, Kuhn has made scientific theory change into an irrational process.

Next, let us look at Laudan’s argument *against* Kuhn’s paradigm model. Laudan’s biggest irk with Kuhn is “…[Kuhn’s] insistence that rationality must be relativized to choices within a paradigm rather than choices between paradigms” (*Dissecting the Holist Picture of Scientific Change,* p. 141). In other words, Laudan does not agree with Kuhn that scientific theory change cannot be rational because it involves switching wholly between two incommensurable paradigms. Laudan does not think that scientific theory change necessarily involves a holistic paradigm switch. He proposes a reticulated model, in which paradigm shifts (if you can even call it that) happen in a piecemeal fashion. It is helpful to look at the steps of scientific theory change under Kuhn’s holistic model and Laudan’s reticulated model to see the differences:

Holistic Model

Paradigm 1: *T, M, V*

Paradigm 2: *T2, M2, V2*

Reticulated Model

Paradigm 1: *T, M, V*

Paradigm 1a: *T2, M, V*

Paradigm 1b: *T2, M2, V*

Paradigm 2: *T2, M2, V2*

As we can see, Laudan’s reticulated model is a much more gradual process than Kuhn’s holistic model. It does not involve a dramatic shift from P1 to P2. Instead, one piece of the paradigm is changed at a time. In fact, in this process, it may not even be helpful to label Paradigm 1 and Paradigm 2 as different paradigms, because they are both small steps in a longer process. Laudan addresses the problem of being unable to rationally compare two steps in the scientific theory change process by making each step have something in common with the previous step. For example, Paradigm 1 and 2 may not be commeasurable, but every step in between is. Laudan solves the conundrum that Kuhn created, giving his own reasons which I will not go into. But what he does not do is address the novel criticism brought up by Kara in class.

For that reason, I will explain Kara’s criticism and offer a counterargument in defense of Laudan. The criticism is that, in reaching Paradigm 2 through the reticulated model, all justifications in Paradigm 1 have been lost. That is, when one switches to Theory 2 in Paradigm 1a, it is acceptable because T2 is justified by the methodology M and abides by the values V. However, once Paradigm 2 is reached, the original justifications for T2 (M and V) have been replaced by M2 and V2. In this way, the reticulated model inevitable reaches a point in which the original justifications for some theory, methodology, or value have been replaced and are therefore no longer valid. Then how can the part, which has lost its original justifications, continue to be a rationally accepted part of the paradigm? This is a valid critique of Laudan’s reticulated model that reveals a potential weakness in his model.

Nonetheless, it is a repairable weakness because it can be removed with some additional specifications to Laudan’s model. Kara’s model assumes that, in our previous example, M2 and V2 are not necessarily enough justification for T, because T’s original justification, M and V, are no longer present. This is correct if we do not consider the possibility that, along each step of the reticulated model’s process, there has been thoroughly complete commeasurement between all theories, methodologies, and values of that step. In other words, to fix the problem that Kara presented, we must assume that Laudan’s model takes each step very carefully. For the transition from Paradigm 1 (T, M, V) to Paradigm 1a (T2, M, V), T2 must have been vetted *completely* by M and V such that T2 is justified by M and abides by V. If the same complete vetting happens for *every single* step of the process, then by the time we arrive at Paradigm 2, T2 no longer needs to be justified by M and V because M2 and V2 have already been shown to be enough. In this way, scientific theory change remains a rational process under Laudan’s reticulated model, despite Kara’s logical criticism.

In other words, previous theories, methodologies, and values are not required to justify future theories, methodologies, and values so long as each replacement theory, methodology, or value is justified by its concurrent theories, methodologies, and values at the step that it is introduced and for every step after that in which it hasn’t been yet replaced. Consequently, Laudan’s reticulated model does in fact improve upon Kuhn’s holistic model because it allows for scientific theory change to be a rational process.

In conclusion, scientific theory change must be a rational process so that we can trust engineers and scientists to continue to create technology that improves our lives. Quality technology relies on qualities scientific theories that are *rationally better* than others. The example of the Tacoma Bridge collapse illustrates this point effectively. Although Kuhn’s holistic model raises questions about the rationality of scientific theory change, Laudan’s reticulated model gracefully answers these questions in a way that preserves rationality. Furthermore, Kara’s strong criticism of the reticulated model is addressable through clarifying the model further by making sure that each step involves a complete vetting process, in which every piece is verified against the others. Therefore, if one accepts the reticulated model of scientific theory change, then the process remains rational and we can continue to trust technology based on scientific theories.