Field Theory

Coulomb’s and Ampere’s Laws of Force describe an “action at a distance” approach to describing the basic electromagnetic forces. In this approach, we can state:

1. A charge at one location in space will exert a force on a charge at another location in space.

2. Current flowing at one location in space will exert a force on current flowing at another location in space.

Alternatively, we can use a “field theory” of electromagnetics. In this field theory, we describe the forces in this manner:

1. A charge at one location in space will create an electric (vector) field at any and all other locations in space. This field will then exert a force on any other charges that exist in space.

2. Current flowing at one location in space will create a magnetic flux density (vector) field at any and all other locations in space. This field will then exert a force on any other current that exist in space.
In other words, in field theory, we state that sources create fields (everywhere)—and then the fields apply the force to other charges or currents!

Q: Good Heavens! This seems to make electromagnetics even more difficult! Why do we use the concept of electric and magnetic fields??

A: Field theory is helpful because it allows us to divide the electromagnetic force problem into two more manageable pieces. Specifically:

1. We can determine the fields generated by source charges or currents, without every having to consider the other charges or currents that they affect!

2. We can determine the effect (i.e., forces) of fields on charges or currents, without every having to consider the sources that created those fields!