Karnaugh mapping, named for its originator, is another method of simplifying logic circuits. It still requires that you reduce the equation to an SOP form, but from there, you follow a *systematic approach*, which will always produce the simplest configuration possible for the logic circuit.

A **Karnaugh map** (K-map) is similar to a truth table in that it graphically shows the output level of a Boolean equation for each of the possible input variable combinations. Each output level is placed in a separate **cell** of the K-map. K-maps can be used to simplify equations having two, three, four, five, or six different input variables. Solving five- and six-variable K-maps is extremely cumbersome; they can be more practically solved using advanced computer techniques. In this book, we will solve two-, three-, and four-variable K-maps.

Determining the number of cells in a K-map is the same as finding the number of combinations or entries in a truth table. A two-variable map requires $2^2 = 4$ cells. A three-variable map requires $2^3 = 8$ cells. A four-variable map requires $2^4 = 16$ cells. The three different K-maps are shown in Figure 5–66.

Common Misconception

Students sometimes design their own layouts for K-maps by moving the overbars. This move can produce invalid results if it causes more than one variable to change as you move from cell to cell.

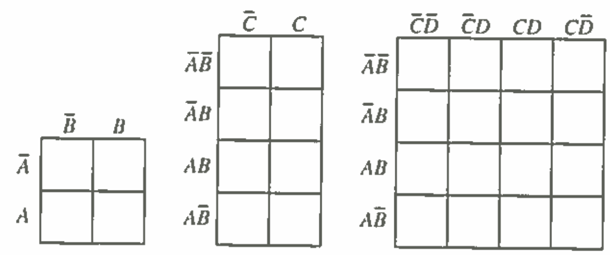

Figure 5-66 Two-, three-, and four-variable Karnaugh maps.

Each cell within the K-map corresponds to a particular combination of the input variables. For example, in the two-variable K-map, the upper left cell corresponds to $\bar{A}\bar{B}$, the lower left cell is $A\bar{B}$, the upper right cell is $\bar{A}B$, and the lower right cell is AB.

Also notice that when moving from one cell to an **adjacent cell,** only one variable changes. For example, look at the three-variable K-map. The upper left cell is $\bar{A}\bar{B}\bar{C}$; the adjacent cell just below it is $\bar{A}B\bar{C}$. In this case, the $\bar{A}\bar{C}$ remained the same and only the $\bar{B}$ changed, to B. The same holds true for each adjacent cell.

To use the K-map reduction procedure, you must perform the following steps:

1. Transform the Boolean equation to be reduced into an SOP expression.
2. Fill in the appropriate cells of the K-map.
3. Encircle adjacent cells in groups of two, four, or eight. (The more adjacent cells encircled, the simpler the final equation is; adjacent means a side is touching, not diagonal.)
4. Find each term of the final SOP equation by determining which variables remain constant within each circle.

Now, let's consider the equation

$$X = \bar{A}(\bar{B}C + \bar{B}\bar{C}) + \bar{A}B\bar{C}$$

First, transform the equation to an SOP expression:

$$X = \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C}$$