Chapter 1

Cellular Antennas

Myths: Overview

There are some predominant perceptions about cellular antennas, including such things as; one antenna is more powerful another, a taller antenna is better than a shorter antenna and the higher the antenna is located the better the signal. These concepts are both correct and incorrect depending on the application, location, geographic terrain and several other factors that will effect performance when using an antenna that is not built into the cellular phone.

Chapter 2

Is a high gain antenna more powerful than a low gain antenna?

No. In absolute terms there is no such thing as one antenna that is more powerful than another because antennas are passive devices (radiators) and they do not create energy, however, antennas are most often rated in dB gain and as such, most people believe that a high gain antenna is better or more powerful than a low gain: for example a 3db gain antenna versus a 0db gain antenna.

In reality, there is no energy increase with a gain antenna. An antenna without gain (0db) radiates energy in all directions equally and antenna with gain redirects or concentrates energy in a certain direction and the gain performance is measured in the direction of the energy concentration. A vertically mounted high gain antenna will concentrate energy more parallel to the earth and will generally perform better when the tower is unobstructed and located on the horizon (oceans, lakes, deserts.), however its vertical radiation will be lower than a low gain antenna.

In very simplistic terms it can be said that a low gain cellular antenna will perform better in geographic areas where signal is bouncing, reflecting or is generally located vertically from the antenna mast (cities, mountains, areas with obstructions). A vertically mounted high gain antenna will direct more of the energy that it radiates parallel to the earth and less energy toward the sky. This antenna will perform better when the tower is unobstructed and located on the horizon (oceans, lakes, deserts). It is advisable for people who travel to remote areas of poor cellular signal and varying geographic terrain to have both types of antennas because of this phenomenon.

Chapter 3

Is a tall antenna more powerful than a short antenna?

No. In the frequencies used in cellular, 0 db gain or quarter wave antennas are very short, usually 4 inches and shorter and gain antennas are usually 8 inches or taller. It is a popular misconception that the bigger or taller the antenna the more powerful or better it is. This misconception may be rooted in the various antennas that we see around us, CB antennas, Police vehicle antennas, two way radio antennas etc. all seem to be quite tall. The length of antennas used in different types of communication is generally dictated by the frequency being used rather than the "power" of the antenna. Lower frequencies have longer wavelengths, therefore to achieve the same radiation pattern with the same energy, antenna length must be longer in low frequency communications than high frequency communications. For example: a quarter wave 0 dB gain antenna that is used for the cellular band should be approximately 3 1/2 inches in length and a 0 dB gain antenna that is used for a CB band should be over 100 inches in length. These two antennas will achieve the same range in their respective frequencies under the same conditions, but their length difference is substantial simply due to the frequency that each antenna is transmitting.

Chapter 4

Is a dual band antenna better than a single band antenna?

No. Ideally, a most efficient antenna should be tuned to one specific frequency, however, cellular communications use a wide frequency spectrum, 824 Mhz to 896 Mhz for the Cellular band and 1850 to 1960 Mhz for the PCS band, therefore sacrifices must be made to make the antenna perform adequately in both bands. This makes dual band antennas less efficient than single band antennas, however, dual band cellular antennas are still reasonably efficient and given the reality that cellular phones will work in either band without the users control, it is usually required that the antenna be as good a radiator as possible in both bands, hence dual band antennas are a necessity, but definitely not better.

Chapter 5

Antenna placement: is higher always better?
Not always. Usually cellular signal is better at higher elevations than near the ground however that is not always the case especially in areas where signal is obstructed, reflecting or fading. The most important consideration when placing an antenna at a higher elevation is cable length. Co-ax antenna cables have loss and cable loss increases with cable length. A calculation must be made to assess the increased level of signal at a given elevation from which the cable losses must be subtracted. If the (signal) measured at the phone end of the co-ax cable is a better number than the signal present in the air at the same location, then higher antenna location is better, if the signal at the phone end of the co-ax cable is lower, then higher antenna placement is not better. It is possible to calculate the effect of antenna placement by measuring the signal level at the phone location and the signal level at the proposed external antenna position and subtracting the loss of a known length of cable with a known loss per foot. One can measure signal level at virtually any location by using an ordinary cellular phone and setting it to "test mode". *To learn about "test mode" click here*.

Chapter 6

Facts
There are several factors relating to antennas that effect cellular performance. These are mostly overlooked while antenna re-sellers talk about and focus on the above stated myths. The biggest mistake is to focus on the gain numbers of the antenna and the antenna itself and disregard all else. Re-sellers often use this preconception to impress the unsuspecting consumer and offer and provide sub-standard goods at top prices. When purchasing an antenna it is recommended to consider all parts of the "antenna system".

Chapter 7

Antenna connections:
The most important factor that will effect the receive and transmit signal of a phone connected to an external antenna is type of connection. There are two connections for the antenna: the connection to the cellular phone and the connection of the antenna to the co-ax cable. On the phone side there two types of connections, some phones have an antenna jack on them that is accessible and the antenna connection is made directly to this antenna jack. Some phones do not have an antenna jack on them and the signal must be transferred from the phone to the antenna cable capacitively using either a "ring type" or "holder type" antenna connector.

The type of connection between the external antenna and the co-ax antenna cable is also equally important. Magnetic mount and through-hole antennas have the antenna cable directly connected to the antenna base. Glass mount (onglass) antennas do not make a direct connection and transfer the signal between the antenna and co-ax cable capacitively.

The difference in performance of the phone will be vastly better when using a"direct connect antenna" with a phone that has a "direct connect" antenna jack on it than when using a phone or antenna that uses a non-direct capacitive method of signal transfer. For example: a phone with a capacitive antenna connection using a glass mounted antenna will have so much loss that one would be better off not using this external antenna. If one was to use a booster under these conditions, an improvement in performance can be achieved but it would be small when compared to using the same booster with another type of phone connection or antenna.

Chapter 8

Antenna placement and groundplane:
Groundplane is the term used to describe the reflective effect on RF signal when an antenna is placed on a piece of steel. When an antenna radiates energy (signal) it will radiate energy in all directions. Some energy will be radiated towards the ground; hence a substantial portion energy is wasted. Radio frequency microwaves cannot penetrate steel and when an antenna is placed on steel, the energy that radiates towards the ground is reflected by the steel to the air. This effect has a profoundly beneficial effect on signal range. An effective groundplane should be at least 1 wavelength wide; this is a little greater than 14 inches for the cellular communication frequencies.

There are several popular locations to mount cellular antennas. The best location is the center of a vehicle roof where it is unobstructed and has a large metal surface (groundplane) under it.

A second choice would be a mirror mount, fender mount or pole-mount using a thru-hole type antenna that passes through a metal mounting bracket. When this type of mounting is used it is recommended that an antenna with a built-in groundplane is used. Antennas with coils, symmetrical horizontal protrusions and other methods are designed for use in places where a metal groundplane is unavailable. An antenna with a built in groundplane will be effective if it is designed well.

A third and very popular mounting type is known as on-glass. This type of antenna mounting configuration is the least efficient of all. This type of antenna does not have the benefit of groundplane and transfers the signal by an electrical phenomenon that is called capacitive coupling. There is signal loss between the antenna and the coupling box on the inside of the glass hence this type of antenna configuration will have inferior performance when compared to the same antenna with same antenna cable that is connected directly to the co-ax cable. It is important to understand that an antenna's gain number and type of antenna mast (radiator) is less significant than how it is connected and where it is placed.

Chapter 9

Antenna cable:
Antenna co-ax cable is the critical component in antenna system performance that is almost always overlooked and is most likely to be of poor or medium grade when an antenna purchase is made. When a cellular antenna is made, the biggest and most expensive part of the purchase should be the co-ax cable. High grade low loss cable for high frequency communications is expensive when compared to co-ax cable used in lower frequency communications, however from the outside it looks the same and to most people, "a cable is a cable".

Most name brand cellular antennas use RG58 or RG174 RF co-ax cable and even though this cable is acceptable when used in lower frequency communications, like CB radio, this grade of cable is mediocre for the high frequency bands used in cellular communications. An RG58 cable that is 15 ft long and with a connector on each end will have a loss of 4 dB or greater in the Cellular 800 Mhz band and upwards of 8 dB of loss in the 1900 Mhz PCS band. A smaller RG174 cable will have a loss of 6 dB or greater in the Cellular 800 Mhz band and upwards of 12 dB of loss in the 1900 Mhz PCS band. Antennas with these cables are useful in the 800 Mhz Cellular band but virtually useless in the PCS band.

To overcome cable losses, the engineers at Smoothtalker designed a quadshielded solid center conductor cable to replace RG58 with less than 1.8 dB loss at 800 Mhz and less than 3.25 dB loss in 1900 Mhz and a smaller dual-shield cable to replace RG174 which has less than 3.5 dB loss at 800 Mhz and less than 7.2 dB loss in 1900 Mhz. Smoothtaker antennas are only sold with Smoothtalker high performance co-ax cable. Cheap co-ax cables are signal killers.

Example of how cable loss affects power: 3 watts of power (from a booster) equals 34.8 dBm. A Smoothtalker booster model BST850 is designed and rated to deliver 3 watts (34.8dBm) to the end of the Smoothtalker cable, which includes 1.8 dB loss. If a lower grade antenna cable is used that has an additional loss of 3 dB, then the power that reaches the antenna is reduced from 34.8 dBm (3 watts) to 31.8 dBm which equals 1.51 watts. The output power is cut in half and the range of the cellular phone is reduced drastically.

Chapter 10

Recommendations:
Always try to match the antenna to the environment, use a groundplane whenever possible, get an antenna with a low loss cable. Note that almost all antennas and the cables that come with them will perform better than a phone inhand, particularly when the phone is used inside of a vehicle. The difference in performance of a good antenna system compared to a mediocre antenna system only comes into play and becomes apparent as the signal becomes weaker and weaker. If you travel to remote or through remote and low signal areas, get the best antenna

system available and you will be rewarded with increased range.