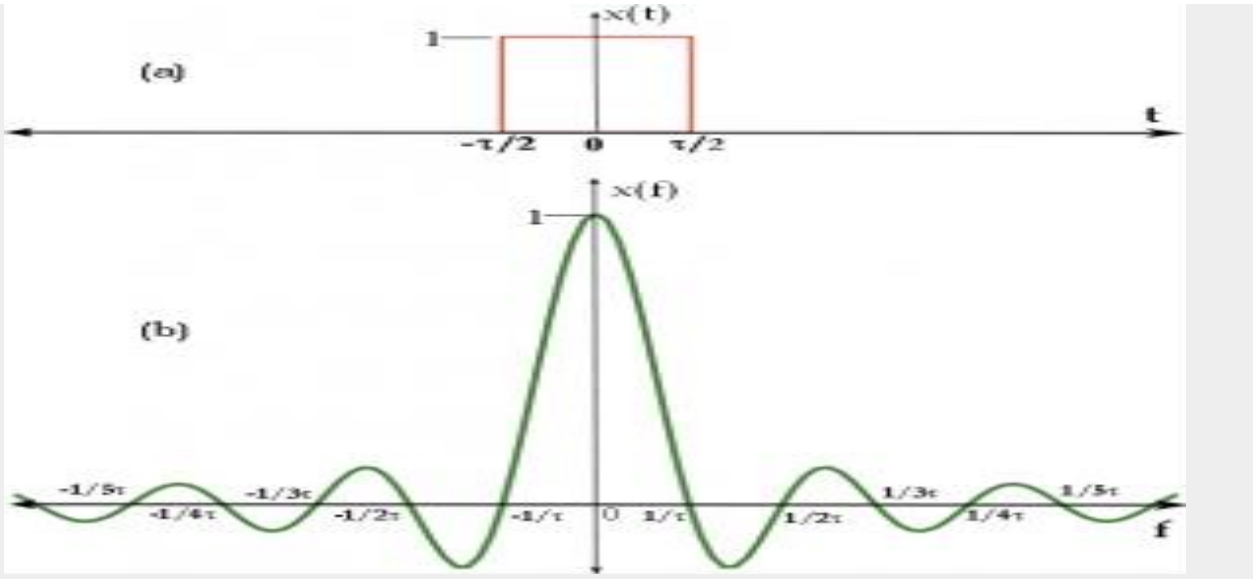
ROLE OF PULSE SHAPING IN COMMUNICATION SYSTEMS

In communication systems, data is transmitted as binary bits (ones and zeros). It is easier to implement a binary system using switches, where turning on a switch represents ’1′ and turning it off represents ’0′. Such simple binary systems essentially represents ones and zeros as rectangular pulses of finite duration (say τ). In frequency domain a rectangular pulse of finite duration τ manifests itself as a sinc pulse of infinite duration. Also, most of the energy of the rectangular pulse is concentrated with in $-1/\tau$ to $1/\tau$ in the frequency domain. This implies a pulse of duration τ requires twice its bandwidth for reliable transmission. This poses a limitation when it comes to bandwidth limited system, if we wish to increase the transmission data rate. The challenge here is, how do we transmit the data with highest possible data rate in a given band-limited system. The answer is : Pulse Shaping.

In a band-limited system, when we try to increase the data rate, it may lead to Inter Symbol Interference (ISI). There are two criteria for a non-interference systems where pulse shaping is employed. (1) The pulse shape exhibits a zero crossing at

the sampling point of all pulse intervals except its own ; (2) the shape of the pulses be such that the amplitude decays rapidly outside of the pulse interval.

A rectangular pulse satisfies the first criterion (where it contains zero crossing – see figure below) but not the second criterion (the energy of the rectangular pulse does not decay rapidly outside the pulse interval and in fact it extends to infinite bandwidth). A raised cosine pulse is designed to satisfy these two criterion and thus provides an ISI free system. See also : discussion on Square Root Raised Cosine Filter , the concept of matched filter and introduction to controlled ISI.



The duals – Sinc and Rectangular Functions

Source: http://www.gaussianwaves.com/2010/12/raised-cosine-filter-2/