The Baugh-Wooley multiplier:

Typical conventional Multipliers have Sign bit extension complexity problem. To avoid this, we will go for Baugh-Wooley multiplier.

The Baugh-Wooley multiplier is a signed multiplier that takes **less complexity** to implement.

Baugh - Wooley Multiplier :

* Typical conventional signed multipliers have one drawback. i.e They are more complex (Due to sign handling problem)

* To avoid this sign handling problem, There's one efficient signed multiplier called "Baugh-wooley multiplier."

* Baugh-wooley multiplier is a signed multiplier with less complexity

Take 2 input 2's compliment represented signed numbers:

$$A = A_3 A_2 A_1 A_0$$
$$B = B_3 B_2 B_1 B_0$$

A_3, B_3 are sign bits.

$$Y = A \cdot B$$

$$Y = A_3 \cdot A_2 \cdot A_1 \cdot A_0 \times B_3 \; B_2 \; B_1 \cdot B_0$$

we have to perform this multiplecation by taking care of signs also.

Take

$$A = A_3 \cdot A_2 A_1 A_0 \; ; \; B = B_3 \cdot B_2 B_1 B_0$$

$$= -A_3 + A_2 2^{-1} + A_1 2^{-2} + A_0 2^{-3}$$

$$B = -B_3 + B_2 2^{-1} + B_1 2^{-2} + B_0 2^{-3}$$ {Normalised 2's Complement representation}

$$Y = AB = [-a_3 + a_2 2^{-1} + a_1 2^{-2} + a_0 2^{-3}][-b_3 + b_2 2^{-1} + b_1 2^{-2} + b_0 2^{-3}]$$

$$Y = a_3b_3 - a_3\left[b_2 2^{-1} + b_1 2^{-2} + b_0 2^{-3}\right] - b_3\left[a_2 2^{-1} + a_1 2^{-2} + a_0 2^{-3}\right] + \left[a_2 2^{-1} + a_1 2^{-2} + a_0 2^{-3}\right]\left[b_2 2^{-1} + b_1 2^{-2} + b_0 2^{-3}\right]$$

Take $a = 1 - \bar{a}$ after some mathematical derivations & re-arrangements, we will get

$$Y = a_3b_3 + \left(\overline{a_3b_2} + \overline{a_2b_3}\right)2^{-1} + \left(\overline{a_3b_1} + \overline{b_3a_1} + 1 + a_2b_2\right)2^{-2} + \left(\overline{a_3b_0} + \overline{b_3a_0} + a_2b_1 + a_1b_2\right)2^{-3} + \left(a_1b_1 + a_0b_2 + a_2b_0\right)2^{-4} + \left(a_1b_0 + a_0b_1\right)2^{-5} + a_0b_0\,2^{-6}$$

$\Rightarrow$

$a_3\ a_2\ a_1\ a_0 \times b_3\ b_2\ b_1\ b_0$

			$\overline{a_3b_0}$	a_2b_0	a_1b_0	a_0b_0
		$\overline{a_3b_1}$	a_2b_1	a_1b_1	a_0b_1	
	$\overline{a_3b_2}$	a_2b_2	a_1b_2	a_0b_2		
a_3b_3	$\overline{a_2b_3}$	$\overline{a_1b_3}$	$\overline{a_0b_3}$			
P_6	P_5	P_4	P_3	P_2	P_1	P_0

$Y = P_6\,P_5\,P_4\,P_3\,P_2\,P_1\,P_0$ got 7 bit o/p with P_6 as sign.

The Architecture will be as follows: