Shift Add Marble Multiplier Simulator

In 2008 Matthias Wandel showed his marble adding machine to the world.
https://www.youtube.com/watch?v=GcDshWmhF4A

In 2016 I attended a hobbycentre where someone had made his own version of this machine.
I immedeiately recognized it and said it was a nice marble adding machine.
The problem with this marble adding machine is the switch. It need good sawing to have it work
as it should. I was thinking of making a simplified version of the marble machine and I did.
I showed it to the other person and he made his version too.
He compared them in this video. https://www.youtube.com/watch?v=hr46VfaVzO0

The main difference between my addingmachine and the one from Matthias Wandel is the fact
that his machine indicates the value of a bit by a switch where my machine indicates the value by
the marble that is captured. This also made me think that dropping a marble from top to bottom
would multiply the held value by 2. It made me think if I could make a marble multiplier that would
multiply by the Shift-Add method.

Years ago it was already possible to do a multiplication with marbles only with a DIGICOMP II.
https://www.youtube.com/watch?v=6KetJ3WpGGE
The multiplication is however done by repeating addition, this is not how you normally would
multiply on a computer. The larger the multiplying values become the longer the program would
need.

Ths Shift Add method would only need the number of bits in the multiplyer as loops in the program
Here is a shift add multiplier in Z80 code for a 8 bit number

```
              LD    B,8
              LD    HL,0
              LD    DE,10
              LD    A,11
LOOP          ADD   HL,HL
              RLA
              JR    NC,NOADD
              ADD   HL,DE
NOADD         DJNZ  LOOP
              RET
```
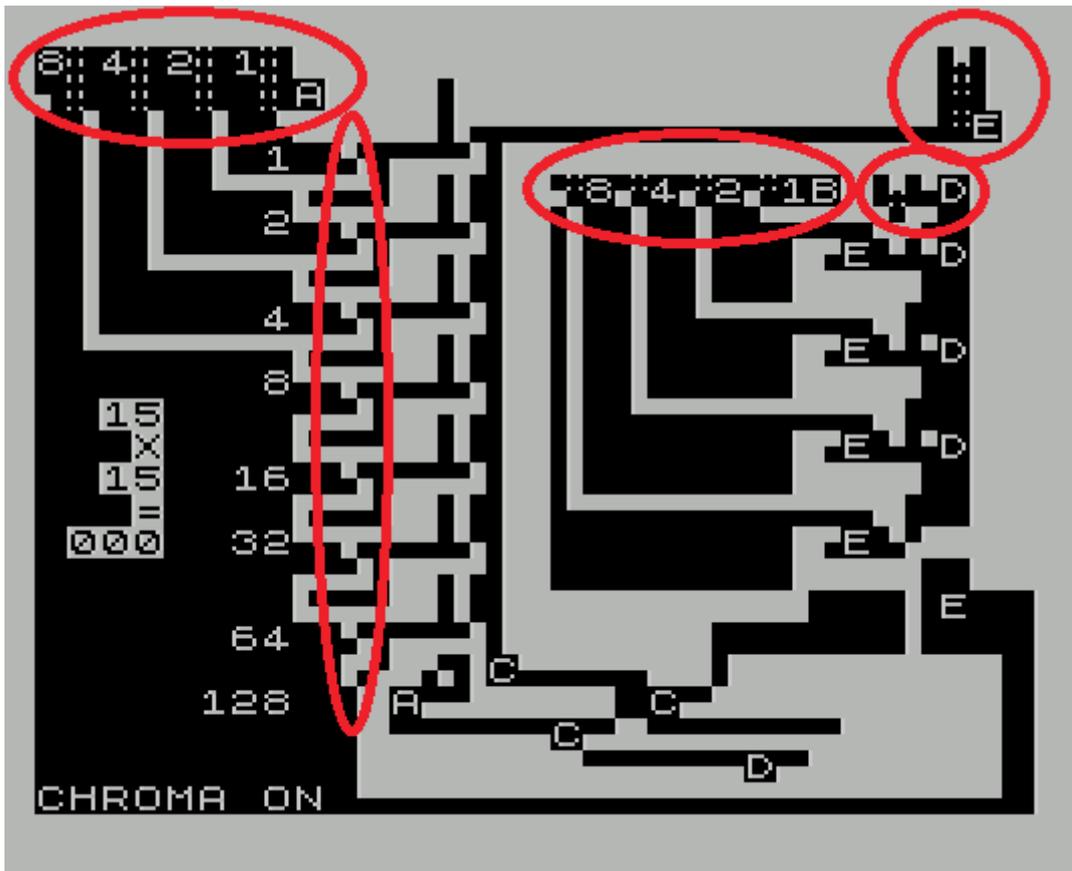
This program multiplies DE (=10) by A (=11)
Since A is a 8 bit number B is set to 8, the matching loopcounter.
HL will hold the result after the code has run.

I built a real multiplier and the only video from it is here
https://www.youtube.com/watch?v=5SnZ_TCs2fE

Now I made a simulator of this machine on the ZX81.

This is the screen of the simulator. I activated the chromacharacters to see the difference between walls and a marble on a static picture. If you saw the video of the real multiplier you will see that some parts are connected with a metal wire to release marbles at the top. On this simulator the connection is done by the letters on the board.

A marble falling through siwtch A at the bottom will release the marbles at the top.

Since this is a simulator sometimes the simulation is simplified over the real machine. This is done to make the simulator fit the screen.

Unlike the program above this is a 4 bit multiplier, not 8 bit.

After loading the simulator you will get a screen like this.
The program will immediately ask you the multiplying values at the left.
The first value is the value that will be put at the position A on top.
The value will be stored 4 times since it is a 4 bit multiplier it could be added 4 times.
You enter a value between 00 and 15, then the same is asked for the second multiplier that will be stored at position B, but only 1x is enough there.

At the top at E 4 marbles are stored, this is the simulation of going 1x time through the loop.
Finally at the top at D 1 marbles is set.

Comparing the simulator with the program this is equal
Position A   = DE
Vertical bits   = HL
Position B   = A
Position E   = the RLA command for marbles at position B
                = DJNZ command for the marble at position D

All E-positions are connected. 1 switch going down means all going down and the same for up.

The carryflag is handled by the C-switch
The multiplication is done by the dropping marble falling from E down over the switches.
Addition is done by rolling over a stored marble. The second marble will drop through a hole to the bottom without hitting other switches.

Finally the bits set are shown in the result display under the "=".
Since marbles keep dropping this value will change during the run.

After input you start the simulator by pressing "B".
If your ZX81 supports chromacharacters you can (de)activate it with pressing "C".
If chroma is not supported the code will run but will show other characters than plotted marbles.
The simulator is slower with chromacharacters.

The chromacharacter checks out which pixel is set by a marble and a matching character is displayed for that pixel. If a marble would fill a block of 4 pixels then for each position
a different character is needed where a normal plot would all give character 128.
A table in the code is capable of doing this task.

At the end the loopcounter will drop straight down to prevent a final addition.
It is the loopcounter and not the multiplier.

You can always start a new run by pressing "I".
See the difference between 1x11 and 11x1 or any other number

You can use this simulator to make your own physical multiplier.
See the video to see how connections are made.