DQMusicBox - music player for people with dementia
How to build one – it's easy

8 January 2017, rosswesleyporter@gmail.com
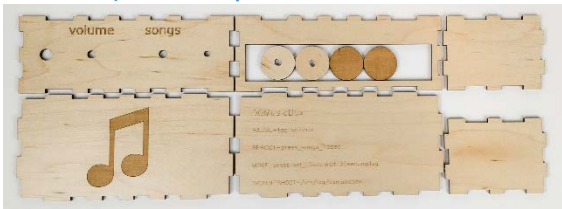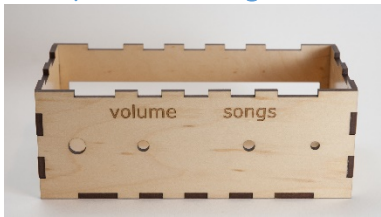
My Dad cannot operate normal music players. But he can operate this music player because it operates like a familiar two-knob radio. My son & I were inspired to design this by the documentary Alive Inside which shows the profound joy felt by some people with dementia when listening to their favorite music.

It's easier than you think to make one. Everything I did (e.g. software, wood case design) is open source. This document contains all the information you need. You can order the parts online. No soldering required.

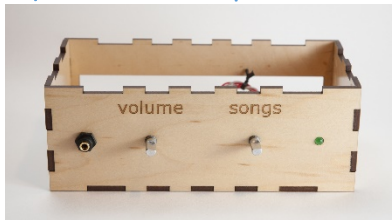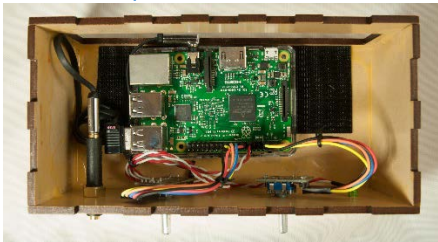|	
Parts cost	$130 - $170 depending on options + tax + shipping most parts from Amazon, includes headphones.
Music cost	Minimal as you should use the recipient's existing music collection.
Build time	About three hours, once you have the parts & music.
Parts source	All parts can be mail ordered, links below.
Soldering?	No.
Command-line Linux?	No.
Tools needed	A computer with an SD card reader, fingers.
Laser cutter needed?	No. You can mail order the pre-cut pieces for the wood case.
Beverage?	Yes. I recommend a hoppy IPA while you are assembling.

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1   Preview of the steps

1) Order parts from Amazon, eBay, Ponoko	2) Assemble recipient's favorite music	3) Copy software to micro-SD card
4) Receive parts from Ponoko	**5) Glue case together**	**6) Screw in front panel items**
7) Place Pi	**8) Connect wires**	**9) Enjoy**

2   No warranty

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3   Acknowledgements

People were very generous with their time, and I really enjoyed the experience. This is certainly an incomplete list: Alex & Mike & others at Ada's, the super smart staff at Metrix, neighbor Randy, Stephen Christopher Phillips, Bob Rathbone, Stephen Rusk, Graham Hill, support at Ponoko, and my son.

4   Change log

If the information below isn't enough for you, check https://github.com/rosswesleyporter/dqmusicbox.

v1.0, November 2015	Original release
v1.1, September 2016	- Changed music storage from a micro-SD memory card to a conventional USB memory stick. - Changed the base Operating System from full Raspbian to DietPi – much smaller, so faster to boot, and less to go wrong.
V1.2, January 2017	Changed from USB audio to Pi built-in audio, including a firmware update for excellent audio quality.

5   What DQMusicBox does

5.1   For the person with dementia

Name	Description & implementation
Start song	Turning either of the knobs will start music playing.
Change song	Turn the songs knob.
Change volume	Turn the volume knob.
Pause	Tap the volume knob. Note that this also happens automatically – music pauses if there are no knob events in one hour.

5.2   For you

Name	Description & implementation
Shut down	Pull the power plug or long hold (15-30 seconds) on the volume knob.
Reboot	Pull the power plug and re-insert or long hold (15-30 seconds) on the songs knob.
Add/remove music	By adding/removing files on the USB memory stick.

6   Ordering the parts

6.1   Create a Ponoko account

Ponoko is a company that laser cuts wood and sends you the precisely cut pieces. You don't need to use Ponoko – you are welcome to take my case designs to your local maker space and cut there. In other words, Ponoko is convenient but not necessary. To create a Ponoko account:

1. Go to https://www.ponoko.com/
2. Choose "Get Making"

6.2   Order the parts

Link to order item	Notes	Alternatives
DQMusicBox wood case (maple veneer)	From the linked page, choose "Add to Personal Factory".	The birch veneer case is $25 less, but the wood is unfinished. Or do the laser cutting yourself using my open source (free) plans from github (/case/dqmusicbox_maple5.svg).
Raspberry Pi 3 Complete Starter Kit (the brains)	Includes a Raspberry Pi 3, plastic case, power supply, micro-SD card. And an unneeded heat sink.	You can also use a Pi 2 or a Pi A+. You will need a small case, power supply and micro-SD card.
KY-040 rotary encoder knobs		If no longer available from this source, you can order from Amazon, but then follow the instructions below for reversing the yellow and orange wires.
StarTech indictor LED		
USB 2.0 8GB thumb drive		Or use your own USB memory stick, but it needs to be physically small as there isn't much space in the wood case.
Female-female jumper wires		
1ft male-male headphone cable		
Panel mount headphone jack		
Sticky back velcro		Or use the sticky back Velcro that you already have.
Elmer's wood glue		Or use the wood glue you already have.
AmazonBasics Lightweight On-Ear Headphones		Or if the recipient already has familiar good headphones, use those instead. Or for $9 less, use these not-quite-as-nice Panasonics.

Check to see if your computer has an SD-card reader. If not, your spouse/child/friend probably has one. If not, you can order a USB SD-card reader for your computer.

Note that this project uses the built-in headphone jack on the Raspberry Pi. And it makes use of some new software from the Raspberry Pi Foundation that makes for excellent audio quality. Previous versions of this project used a USB audio adapter, but that's not necessary any more.

7 Assemble the personalized collection of music

7.1 Choosing the music – go for familiar favorites

This is the most important step. The personalized (familiar) music is the fundamental magic. You don't need much music, perhaps 6-10 albums. But only familiar favorites. One of the few benefits of dementia is that you don't remember what you just listened to and thus don't get tired of your favorite albums. In my case, my Mom mailed me my Dad's favorite CDs. It will take two weeks for the parts above to arrive, so you have time to do this well.

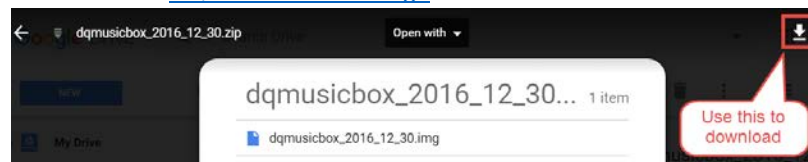## 7.2 Put the music on the USB memory stick

Organize the digitized music into folders on the USB memory stick, one folder per album. MP3, iTunes, and FLAC files are supported i.e. files with extensions .mp3, .m4a, .flac. In the end, you should have a set of folders that looks something like this:
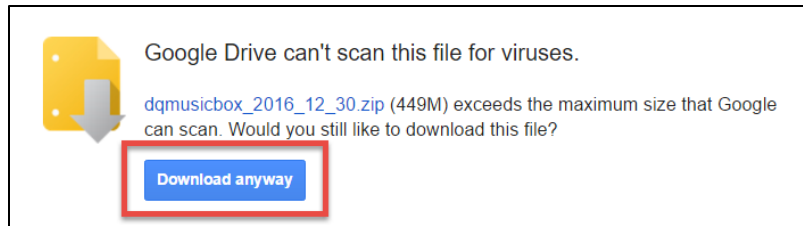
Name	Date modified	Type
A_Beethoven9	10/24/2015 6:25 PM	File folder
B_Eli_Porter_-_Eli_Porter	10/24/2015 6:25 PM	File folder
C_Mozart_-_Overtures	10/24/2015 6:25 PM	File folder
D_Tchaikovsky_-_Concerto for Violin i...	10/24/2015 6:25 PM	File folder
E_Vivaldi_Telemann_Bach_Mercadante...	10/24/2015 6:25 PM	File folder
F_Samuel Barber_-_Barber; Adagio for ...	10/24/2015 6:26 PM	File folder
G_James Galway_-_Serenade	10/24/2015 6:26 PM	File folder
H_Giacomo Puccini_-_Madama Butter...	10/24/2015 6:26 PM	File folder
I_Giacomo Puccini_-_Madama Butterfl...	10/24/2015 6:26 PM	File folder
J_Giacomo Puccini_-_Madama Butterf...	10/24/2015 6:26 PM	File folder
K_Leontyne Price_-_Arias	10/24/2015 6:26 PM	File folder

8 Prepare the micro-SD memory card

I prepared a disk image for you. Your job is to download this disk image and then write it to the micro-SD card. The steps:

1. If you are using Windows, install Win32 Disk Imager. This is what I use.

2. If you are using a Mac, try ApplePi-Baker. I haven't, but online articles recommend it. If a recent version (e.g. v1.9.4) doesn't work for you, try v1.5.1.

3. Download the DQMusicBox disk image. 449MB.

Google Drive can't scan this file for viruses.

dqmusicbox_2016_12_30.zip (449M) exceeds the maximum size that Google can scan. Would you still like to download this file?

Download anyway

4. Unzip to extract dqmusicbox_2016_12_30.img.

5. Put the micro-SD memory card into the SD card adapter i.e. put the tiny card into the larger card.

6. Put the SD card adapter into the SD reader/writer in your computer.

7. Start the Win32 Disk Imager program, instruct it to write the image file to the SD card:
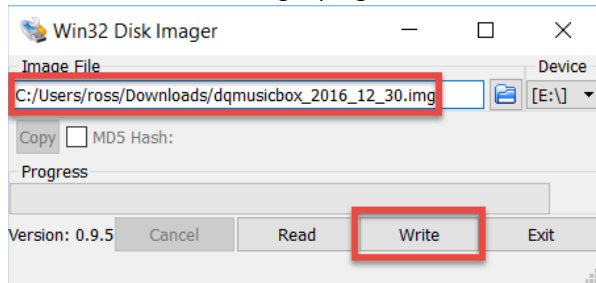
8. Wait for the writing to complete, ~10 minutes. This would be a good time to make a sandwich.

9   Put it all together

What you should end up with (with top removed):
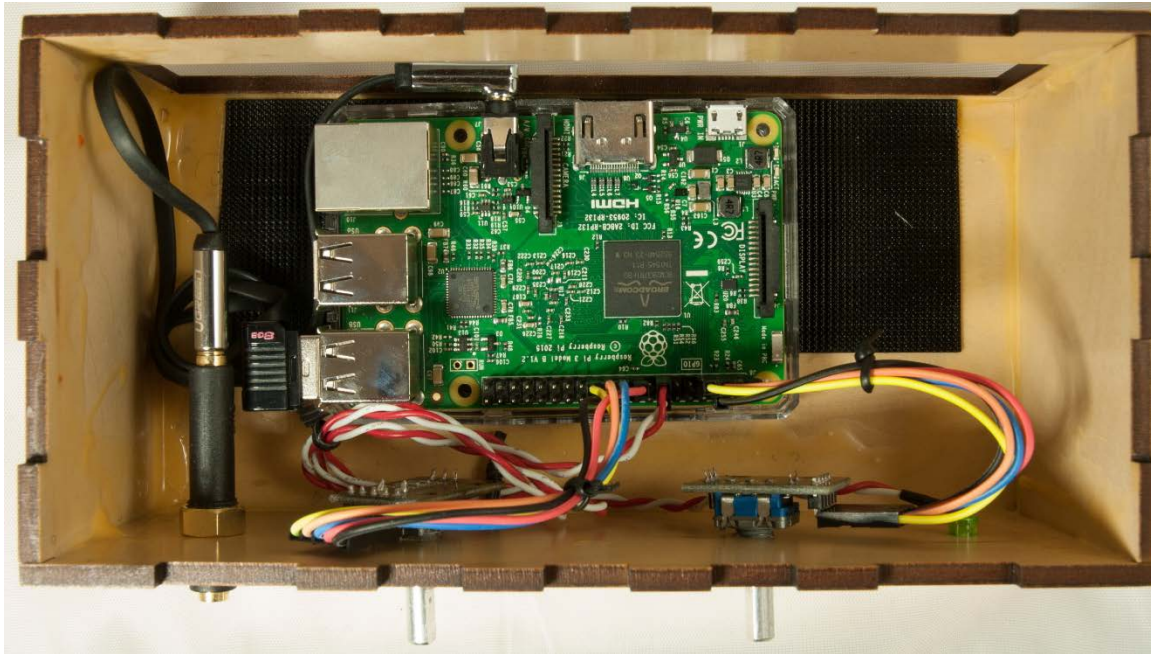
I don't think you need all the steps listed out. But here are a few tips for putting it all together:

1. If you are using the default maple wood case, you don't need to stain or otherwise protect the case.
2. Glue the bottom and sides of the wood case. Put the top on, but don't glue it. Use painter's tape or other to hold the box together while the glue dries.
3. Put the Raspberry Pi into the plastic case.
4. Insert the USB memory stick into a USB port on the Raspberry Pi.
5. Put the micro-SD memory card into the Raspberry Pi memory card slot.
6. Use Velcro to hold the plastic case (and its contents) in place in the wood case.
7. Mount the rotary encoders in the two medium-sized holes in front panel.
8. Mount the headphone jack in the large hole on the front panel.
9. Connect the headphone jack on the Pi to the headphone jack that you just installed in the case.
10. Find the indicator LED labeled HDD. Push this LED into the small hole in the front panel, it should fit snugly.
11. Mount the headphone jack connector in the large hole in the front panel.
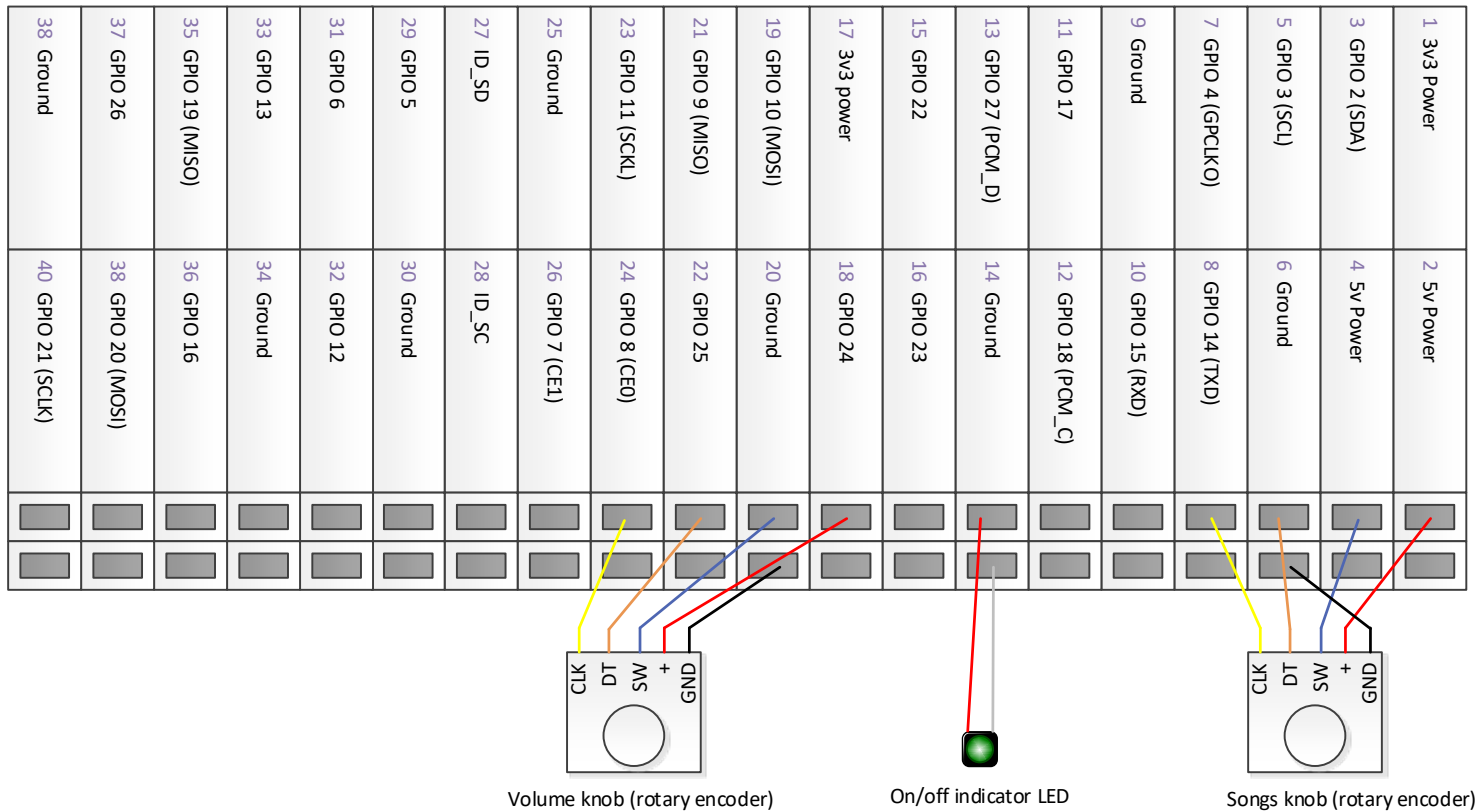12. Now add the wires:

You'll start from the unused pins on the Pi, which are arranged in two rows of twenty pins:

Your goal is to make it look like this:
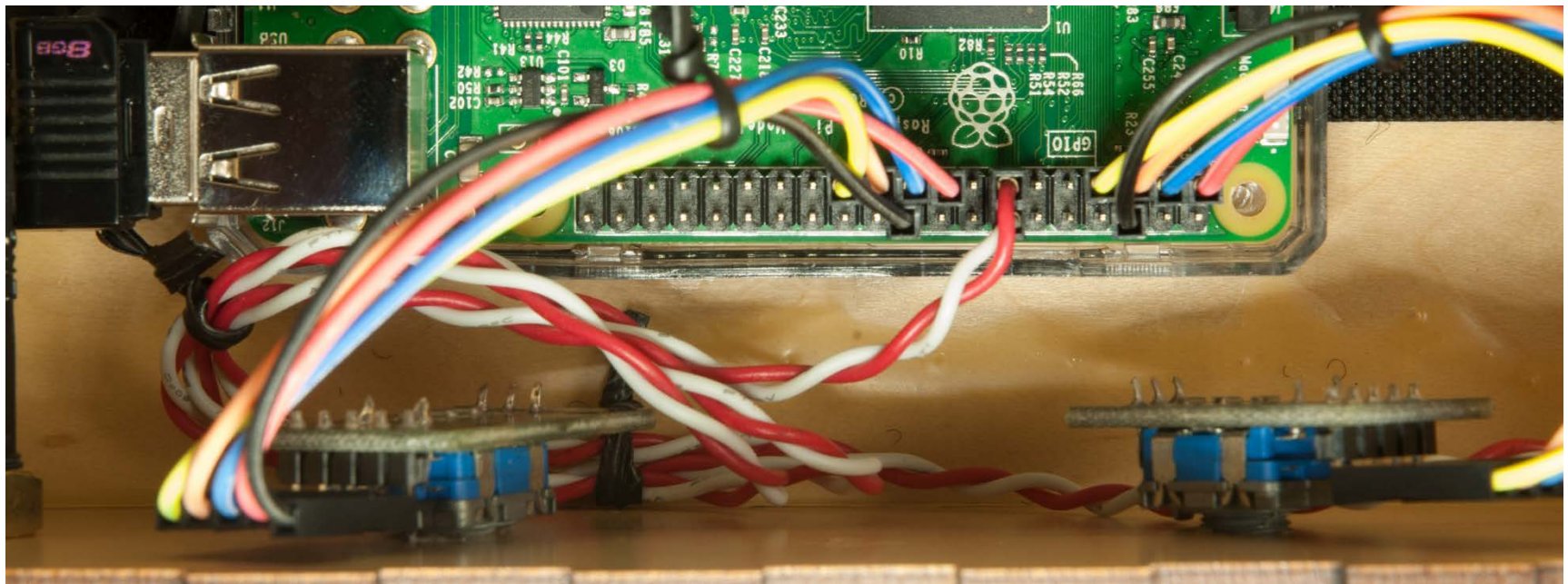
Use the wiring diagram below to make the right connections. Just push the jumper cables in place – no soldering unless you really want to.

Raspberry Pi GPIO header — pin layout (left to right):

Top row (odd pins): 38 Ground · 37 GPIO 26 · 35 GPIO 19 (MISO) · 33 GPIO 13 · 31 GPIO 6 · 29 GPIO 5 · 27 ID_SD · 25 Ground · 23 GPIO 11 (SCKL) · 21 GPIO 9 (MISO) · 19 GPIO 10 (MOSI) · 17 3v3 power · 15 GPIO 22 · 13 GPIO 27 (PCM_D) · 11 GPIO 17 · 9 Ground · 7 GPIO 4 (GPCLK0) · 5 GPIO 3 (SCL) · 3 GPIO 2 (SDA) · 1 3v3 Power

Bottom row (even pins): 40 GPIO 21 (SCLK) · 38 GPIO 20 (MOSI) · 36 GPIO 16 · 34 Ground · 32 GPIO 12 · 30 Ground · 28 ID_SC · 26 GPIO 7 (CE1) · 24 GPIO 8 (CE0) · 22 GPIO 25 · 20 Ground · 18 GPIO 24 · 16 GPIO 23 · 14 Ground · 12 GPIO 18 (PCM_C) · 10 GPIO 15 (RXD) · 8 GPIO 14 (TXD) · 6 Ground · 4 5v Power · 2 5v Power

Volume knob (rotary encoder) — CLK DT SW + GND

On/off indicator LED

Songs knob (rotary encoder) — CLK DT SW + GND

Note: the various rotary encoder manufacturers don't seem to agree on which pin indicates clockwise and which pin indicates counter-clockwise. If your music box is so reversed (e.g. if a clockwise turn *decreases* volume), then just change the orange & yellow wires on the rotary encoders:

- o For the volume knob rotary encoder:
    - ▪ Leave the orange wire on pin 9 on the Pi, but now connect the orange wire to the CLK pin on the rotary encoder.
    - ▪ Leave the yellow wire on pin 11 on the Pi, but now connect the yellow wire to the DT pin on the rotary encoder.
- o For the songs knob rotary encoder:
    - ▪ Leave the orange wire on pin 3 on the Pi, but now connect the orange wire to the CLK pin on the rotary encoder.
    - ▪ Leave the yellow wire on pin 4 on the Pi, but now connect the yellow wire to the DT pin on the rotary encoder.

10 Test cases

Now that you have assembled everything, it is time to test.

Name	Description & Expectation
Light 15sec after power on	The indicator LED turns on when DQMusicBox is ready to play music, which is generally about 15 seconds after power on.
Start song	Turning either of the knobs will start music playing.
Change song	Turn the songs knob. If you go forward and backward through the song list as expected, then all is well.
Change volume	Turn the volume knob. If the volume goes up and down as expected, then all is well.
Pause	Tap the volume knob, song should pause. Tap the songs knob, this should also pause the song.
Shut down	Long hold (15-30 seconds) on the volume knob.
Reboot	Long hold (15-30 seconds) on the songs knob.

11 Congratulations

Congratulations! You should have a fully functional DQMusicBox.