By Colin Daly 12/2022 - www.97percentfire.co.uk

‘Can you build an effective ‘room in a room’ DIY home studio that is Inexpensive, sustainably sourced, reusable, and relocatable without altering the host room?’

Introduction

The focus of this report is to assess if an ‘average room’ in a domestic building could be converted into a non-permanent space suitable for audio recording and/or mixing duties. For the purpose of this report, the room in question will be 2m long by 3m wide by 3 m high and of around 18 m3 as noted as ‘average size’ by the Royal Institute of Chartered Surveyors – RICS, Joyce J (BBC News, 2011).

The topic focus will be on ground-floor rooms, for example, a dining room, office, or garage on the assumption that these have a concrete sub-floor and will not be limited to the weight the floor can carry, unlike the upper floors. The conversion will also focus on a non-commercial application and will use non-specialist building materials readily available from any large DIY store. Those materials will be sustainable and multiple use allowing for upcycling and/or the rooms dismantling for relocation, if the recording space needs converting back to original standard use.

Room in a Room Requirements

It is generally accepted that the ideal construction of a space used for recording should be decoupled from the host building, to reduce the transmission of sound energy into and from that space. White P (Practical Studio Design: Part1, 1993) In commercial studios, this is achieved using advanced construction methods and specialist materials including isolating floating floor systems. Similar methods of reducing sound transmission are already regularly used in new build houses and flats as described in the Government's 'document E' - Resistance to the passage of sound, building regulations 2010' and can be used to create a low-cost room within a room solution. Building Regulations ('ADE_LOCKED.pdf', 2010) Room within a room – before and after 'the studio' Diagram Daly (2022) Pages – Apple UK

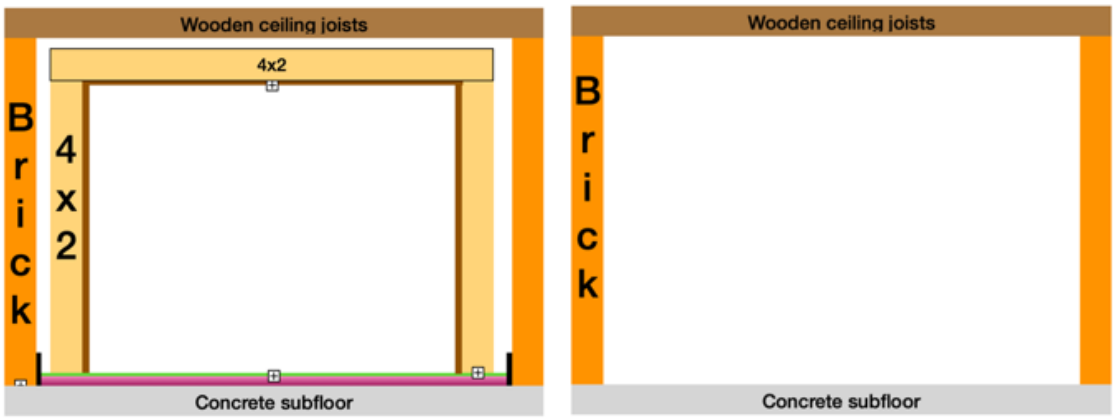


Diagram - Room within a room – before and after 'the studio' (C Daly 2022)

Put simply, a 'studio' can consist of a large decoupled wooden box, built inside the desired host room. For the space to function appropriately, meticulous detail in the construction and execution of the build is needed to prevent unwanted sound transfer.

Flooring Method

Decoupling

An isolating barrier at skirting board level will prevent the suspended studio flooring from meeting walls of the host rooms. 100mm foam-based expansion joint at roughly £10 a role is suitable for the application. Other solutions e.g. Neoprene although an excellent insulator, but at nearly £100 per roll it is prohibitively expensive, and would defeat the 'DIY purpose' for the rest of the build.

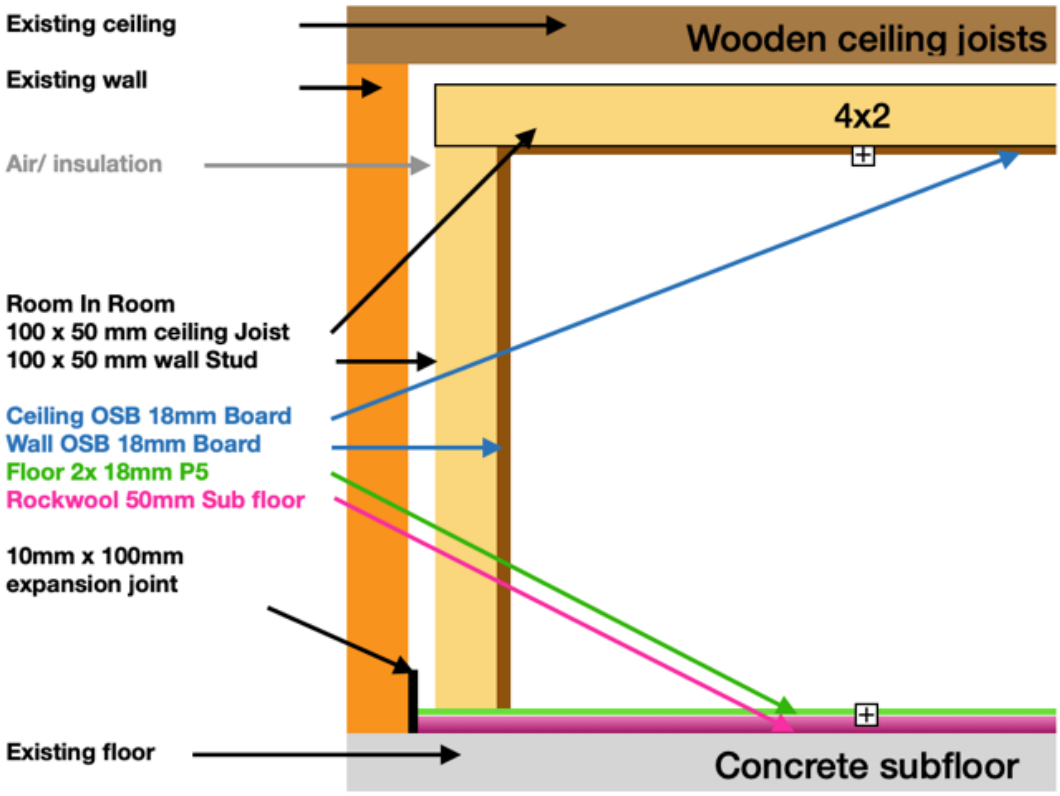


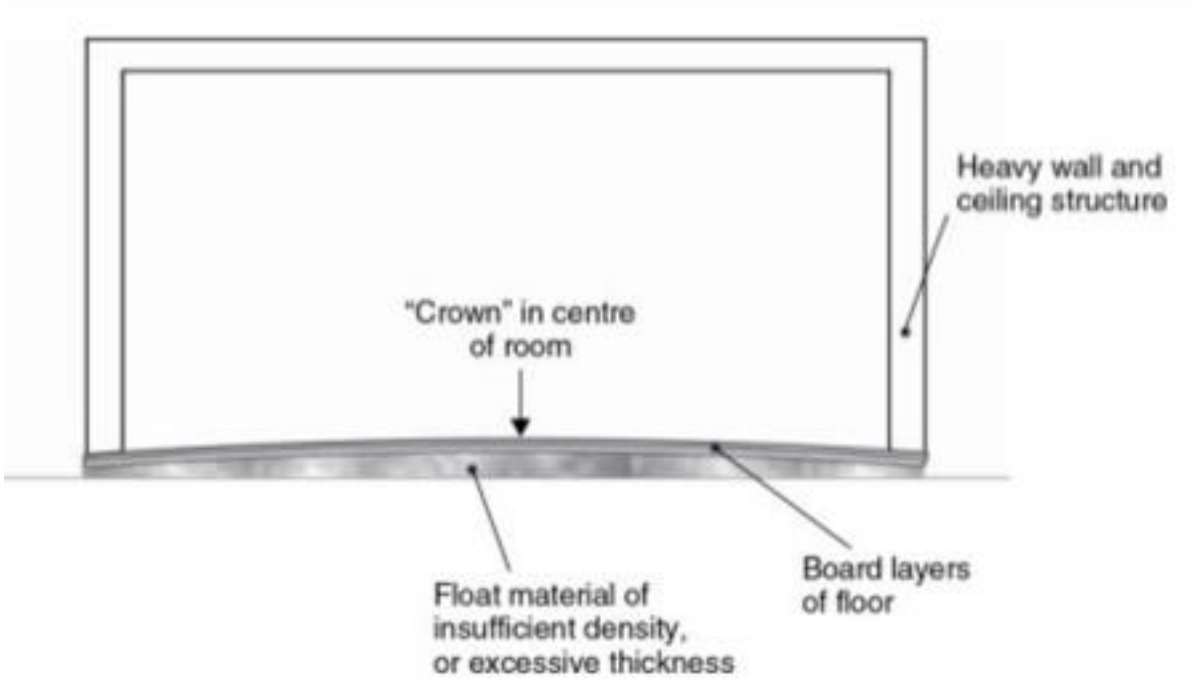
Diagram - The individual components of the 'room in a room' construction (C Daly 2022)

Crowning and Mass

The studio floor is laid on top of the insulation using standard 18mm x 2400mm x 600mm P5 chipboard flooring sheets. This will be laid in two layers in opposite directions, each glued and screwed to each other to avoid potential crowning. Doubling of this chipboard mass also helps reduce the amount of transmitted sound by up to half. Wooden floors do not have the same mass as concrete to significantly reduce for example 'a bass guitar' however, this will reduce the structural bourn sound transmission.

Compression Range

For the floating floor to be effective, the material used to support it, for example, Rockwool insulation would need to be in the middle of its compression range. Too much weight would compress the material and allow for no absorption, creating a flanking path. As each studio, and its content will be different this would need to be calculated on an individual basis. Newell P (Recording Studio Design, 2008)



The potential 'Crown effect" as discussed by Newell (2013) Recording Studio Design 2nd Edition Chapter 3.

Individual Isolation

Once completed the same decoupled floated floor technique can be replicated to create small isolation platforms - for example, to mount a guitar amp without losing significant headroom across the whole space.

Photo - Floating floor. P5 chip wood floor laid on Rockwool - foam perimeter (C Daly 2022)

'Acoustically absorbent material such as Rockwool can help when placed between partitions, though you must ensure that everything is absolutely airtight.'
White P (Practical Studio Design: Part3, 1993)

Rockwool was chosen as its inexpensive, can be reused or up cycled, (e.g. as the infill for DIY acoustic panels) Material alternatives with a greater level of sustainability include, e.g., sheep's wool insulation, (Knauf Rocksilk RS60 - Rock Mineral Wool Acoustic and Thermal Insulation Slab) however, this takes up extra space to achieve the same absorption as it has a lower Gas Flow Resistance. Acoustic Modelling (Multi-layer Absorber Calculator, 2011)

Wall Method

The walls will sit upon the floating floor directly and be constructed using traditional framing 100mm x 50 mm (4x2) timber at 400mm centres. This arrangement will provide a space for the cavity wall insulation to be tightly fitted between the timbers, reducing airgaps. The wall will then be covered (skinned) with two layers of chipboard, to add density with staggered joints. One layer of chip board could be replaced with fibreboard, as per the BBC Research and Development Division. “Using fibreboard, the isolation of the partition between 50 Hz and 250 Hz is six dB higher on average in the isolation of the partition, then when using two layers of plasterboard.” Plumb G. D. (The airborne sound insulations of timber-framed partitions, 1991)

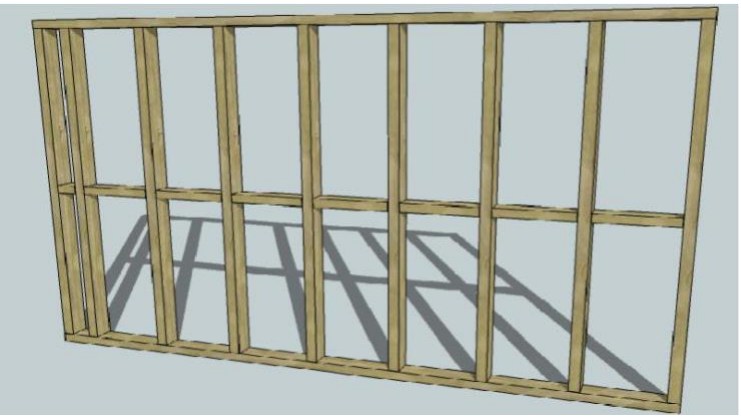


Diagram - Stud wall 100x50mm (Stud Wall Regulations - DIY Extra, 2022)

Plasterboard

Many studios use plasterboard as a key component, as this is Industry standard in construction and best for a permanent structure. However, the environment agency, calculate that up to 30% of new plasterboard each year is waste, and this waste cannot go to landfill as it generates hydrogen sulphide (H2S) when mixed with biodegradable materials. Elliott (‘landfilling of gypsum.pdf’, 2022). As an alternative FSC Certified woodchip (OSB) 8’x4’ board and flooring have been chosen as sustainable alternative. Forestry Stewardship Council (FSC Connect, 2022). This choice although financially practical performs less well as an acoustic isolator.

Absorption coefficient chart.

Reflective wall materials	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Plasterboard (12mm (1/2") paneling on studs)	0.29	0.1	0.06	0.05	0.04	0.04
Plywood (10mm(3/8") paneling, airspace, light bracing)	0.28	0.22	0.17	0.09	0.1	0.11

(Sound Absorption Coefficient Chart Showing the difference between plasterboard and timber. Chart - JCW Acoustic Supplies, (2021).

"Rockwool floor - effective sound absorption will take place when the depth of an absorbent material approaches one-quarter of a wavelength. 10 cm of mineral wool (Rockwool, etc.), covering a wall, will absorb sound. Speech frequencies, around 1000Hz, with a wavelength of around 34 cm will be maximally absorbed, because the quarter wavelength would be 8.5 cm, so the 10 cm of absorbent would adequately exceed the quarter wavelength criterion" Newell (Recording Studio Design, 2nd Edition, 2013)

Air Gap

"Re-reflexion between layers, Resonant build-up in an air cavity can reduce isolation in a similar way to which the build-up of reverberant energy in a space can make a source louder than it would be in free-field conditions" Newell (Recording Studio Design, 2nd Edition, 2013)

To prevent 'resonate build up' in the cavity the 100mm gap between the studio wall and the parent wall needs to be filled with insulation, increasing the gap and the insulation would improve the isolation at low frequencies. However, this would reduce the usable space and as such is an accepted compromise for a non- professional small home studio application.

Airlock Door

The weakest part of the room from a sound isolation point of view will be the doors as these cannot be permanently sealed. A two-door airlock system is to be installed with one door being the original of the host room, if not already doing so this will need to be opening outwards. The second door will be hung on the 'room in a room' partition walling to ensure decoupling. Both doors are to have a solid core and be backed with an extra sheet of ply, rubber gaskets and a pressure. Lock handle will be needed to ensure a tight fit when closed. "In order for the construction to be fully effective, care should be taken to correctly detail the junctions between the separating walls and other elements such as floors and roofs, recommendations are also given to the construction of those elements where it is necessary to control flanking transmissions" Building Regulations (building Regs)

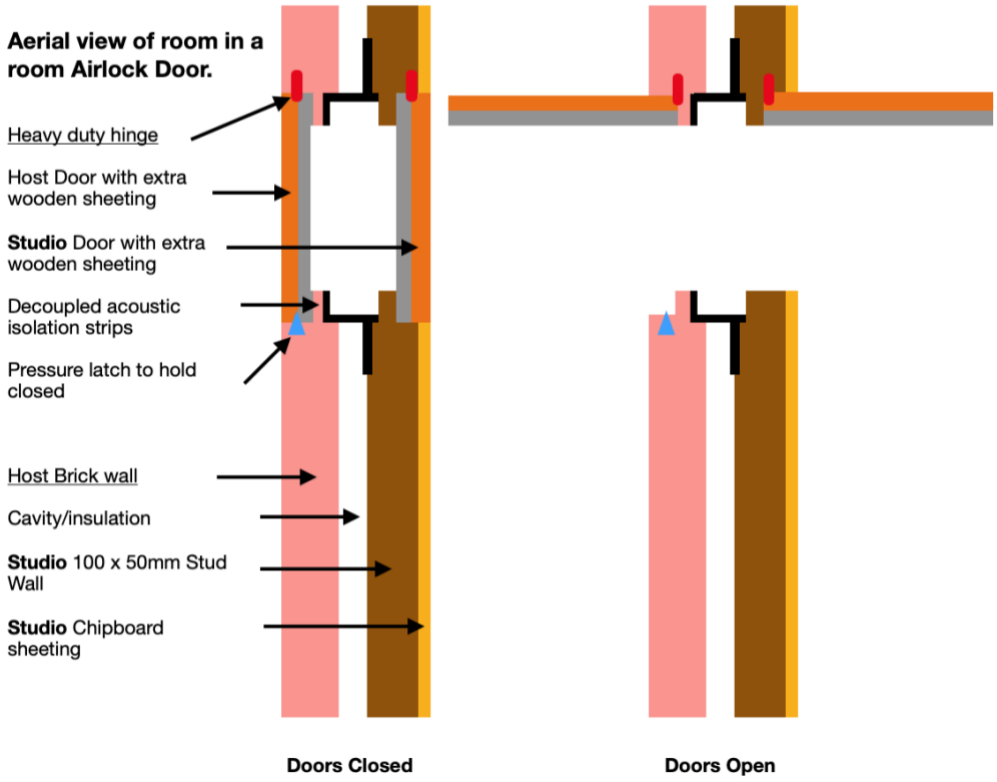


Diagram - The host room and studio door isolation, and decoupling detail (C Daly 2022)

Windows

The ideal scenario would be eliminating windows within the inner room and have a solid wall to prevent transmission loss. However if a window is required then a 'removable' isolation sheet can be used. 'A window with insufficient transmission loss (TL) would be a weak link that would seriously compromise the acoustical isolation of the wall. For example, a well-built staggered-stud or double-stud wall might have an sound transmission class (STC) rating of 50 and provide sufficient isolation' ALTON F ('EpubReader', 2014) If this is not practical or desirable, finances allowing, PVB acoustic glazing can be installed with the host rooms existing window to allow for natural light while in use.

'Noise reduction by 25dB is observed in standard double-glazed units with two glasses of 4mm each with an air cavity in between. A noise reduction spectrum for acoustic glazing ranges from 36dB to 52dB for double glazing.' GLAZING CENTRE (Understanding Acoustic Glazing, 2020)

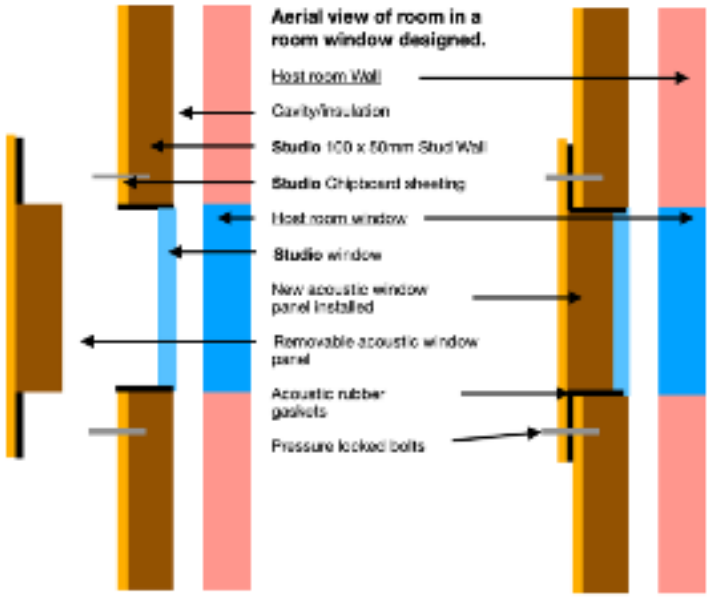


Diagram – Studio/host room window - PVB, acoustic glazing and plug (C Daly 2022)

Room Shape

The room shape and size are dictated by the Host room. Given its limited nature it would not be practical to create complex shapes, however the two parallel side walls have been 'angled in' from parallel – a 100mm taper at one end is used to create a trapezium and reduce standing waves.

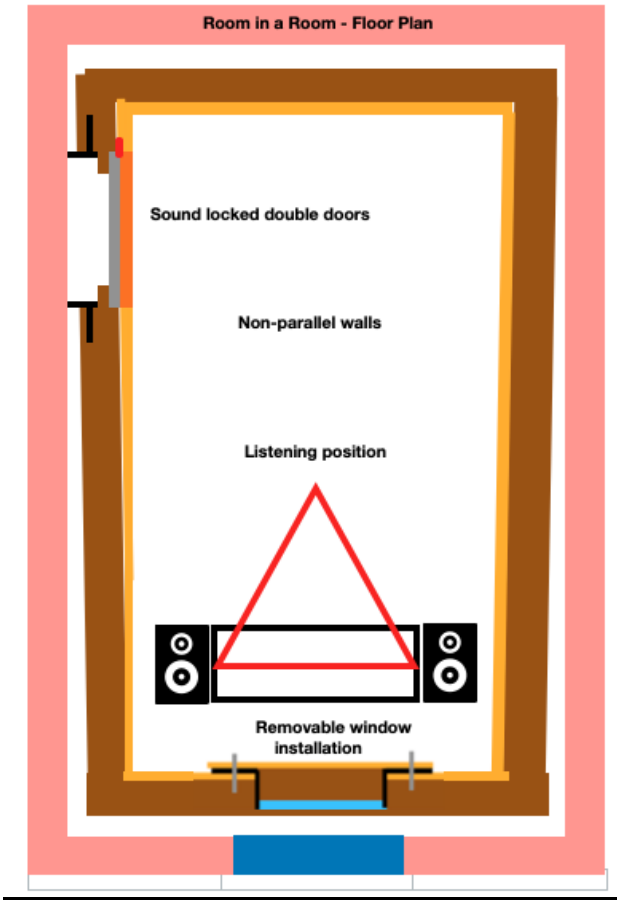


Diagram – Room shape (C Daly 2022)

Ceiling Method

The celling is constructed using the same timber frame method and materials as the walls. The ceiling is mounted and screwed directly upon the inner frame to ensure decoupling and prevent any damage to the host room. A ceiling cloud would be used to help eliminate reflections.

Power

Electricity will be fed to the studio using the host rooms existing sockets via a flexible cable to prevent flanking paths. The entry point to the studio will be corked to make it air tight and utilise an acoustic putty pad (Acoustic Putty Pad, 2021)

Three compartmental trunking can be attached to the inner walls of the studio. This will be mounted on foam installation or similar (e.g. Neoprene). This trunking has the advantage of being able to separate the audio and power cables and allow for an extra earth feed for grounding purposes.

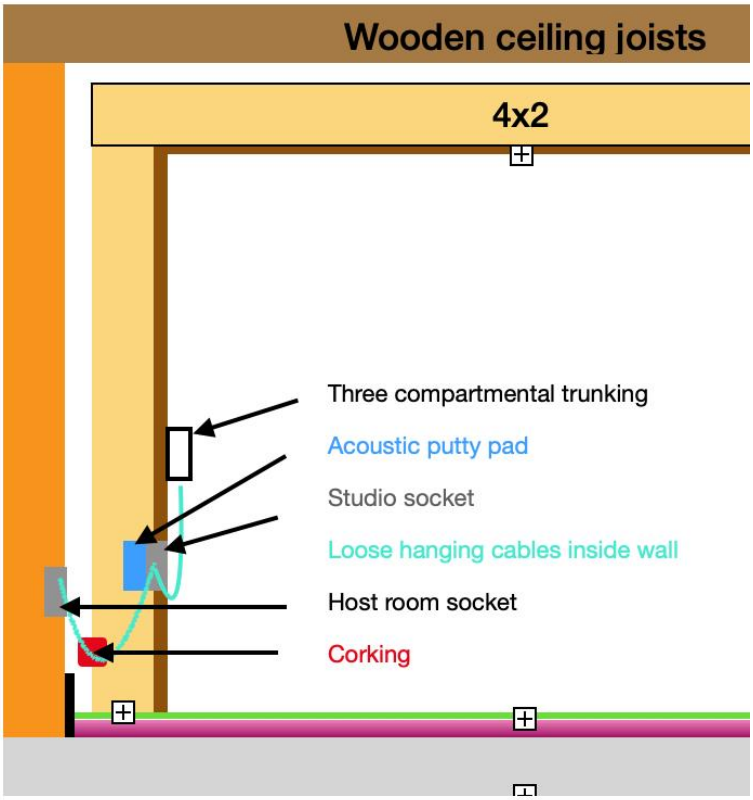


Diagram – Power Flanking path (C Daly 2022)

Diagram showing how electricity will be connected from the host room into the studio without creating a flanking path. 'Flanking sound can travel by a combination of airborne and structure borne paths from the noisy space to the protected area though an attic space or a subfloor space. Such flanking sound can easily nullify the cost spent on improving a shared wall.' Alton F (EpubReader, 2014)

Conclusion

The ‘room within the room’ DIY budget home studio is by design a compromise. As such, it is no surprise that the final product has some limitations, both practically and sonically and as such reducing sound pressure levels would be needed for mixing and recording to prevent unwanted sound transmission. ‘Mixing at a relatively quiet SPL of 75 dB is at the lower end of the preferred range for music mixing, because it is already descending into a region where the ear is less sensitive to the upper, and especially the lower frequency range will absorb sound. Newell P (Recording Studio Design, 2007)

Comparison

As very few studio spaces will be identical. It is hard to make a like for like comparison and instead, it would be more useful to quantify need and performance, given available space and financing.

Cost

An off the shelf studio kit measuring roughly half the size of the ‘Room in a Room’ studio would cost in excess of £10,000 (‘ONE-XXL-spec-and-pricing-July-2022.pdf’, 2022) The Materials for the DIY ‘room in a room’ excluding acoustic treatment would cost around £3000 (‘Wickes.co.uk’, 2022) this represents a significant cost saving.

RT60

The theoretical base RT60 of the room (with Chipboard on all services) is RT60 = 3.220. It would be unlikely that 100% chipboard would be the final finish, this would however allow for tailoring for specific room requirements e.g. dry, Voiceovers, or reverberate singing. At 2000Hz chipboard has a coefficient of 0.05 while e.g. Carpet has a coefficient of 0.60.

Pros and Cons

Cons

- Limited number of occupants.
- Limited sound isolation.
- Renewable material choice hampers isolation effectivity.
- DIY skill level will affect build quality and noise reduction etc
- Size and shape dictated by host room not Golden Ratios
- Will need to monitor audio and refence check low end using headphones
- Will need to record via loud Instruments via DI
- A considerable time investment

Pros

- Dedicated, creative, space.
- Ability to work in a more controlled acoustic environment.
- Space that is tailormade and can adapt to the required and changing needs.
- Can use removable absorption and diffusion to change characteristics.
- Cost effective near limitless studio time.
- A more productive 'Set it and forget it' workflow.
- Countless upgrade potentials in line with future learning.

The DIY 'room in a room' studio is an ideal steppingstone when creating your first recording and editing environment. 'Creating a relaxed atmosphere, conducive to the process of creating and performing was a common theme, most often referred to as 'creating the right vibe'... It's getting everyone relaxed and into it... If a client feels happy and comfortable they will more likely be creative are they? (Anthony, producer, West London) (Creating the Right 'Vibe': Emotional Labour and Musical Performance in the Recording Studio, 2013)
The benefit of such a room, compared to e.g. working in a bedroom are numerous and support the creation of such a space, if nothing else, the process of creating a studio is in itself a way to further understand sound and will ultimately be creatively beneficial.

Q ‘Can you build an effective ‘room in a room’ DIY home studio that is Inexpensive, sustainably sourced, reusable, and relocatable and does not alter the host room?’

A ‘Yes’

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- Andrew Masters, YouTube epic home studios
- Produce like a pro studio, Tours
- Prim acoustic - Controlling Sound with Absorption
- Emotional Labour and Musical Performance in the Recording Studio, 2013)
- Wicks - Building Materials

Sabine's Equation calculations

Location L W H					Volume m2	Volume m3	
Control Room							
Chipboard wall A		2.000	3.000		6.000		
Chipboard wall B		3.000	3.000		9.000		
Chipboard wall C		2.000	3.000		6.000		
Chipboard wall D		3.000	3.000		9.000		
Chipboard Ceiling		2.000	3.000		6.000		
Chipboard Floor		2.000	3.000		6.000		42.000
Room Size	3	2	3				
					Room volume	42.000	
Control room volume	Chipboard	Carpet					
42.000	42.000	6.000					
Total m2							
42.000	42.000	6.000				48.000	
NRC Rating	0.05	0.69					
total m2 * NRC	2.100					2.100	NRC
	0.161						
V 104.316 (m3) Volume	42.000	V					
	6.762						
A 3.134 - (Sa) coefficient total	2.100	Sa					
RT60 = 0.161 x V = 42 / A 2.1							
RT60 = 3.220	3.220						

Sabine's equation for 100% chipboard, including door and window covering Daly (2022)

Materials and cost

	linear metres	Sheet 8x4	m2
Walls 4x2	100.000		
walls Chipboard		21.000	
Ceiling 4x2	23		
Ceiling Chipboard		5.000	
Floor chipboard			6
Ceiling Chipboard		5.000	
Quantity	123.000	31.000	
Cost	952.000	837	93.780

(Rockwool Acoustic Cavity slab (L)1.2m (W)0.6m (T)50mm, Pack of 12 | DIY at B&Q, no date) Pack of 12 £80 (£9.25 Per M2)

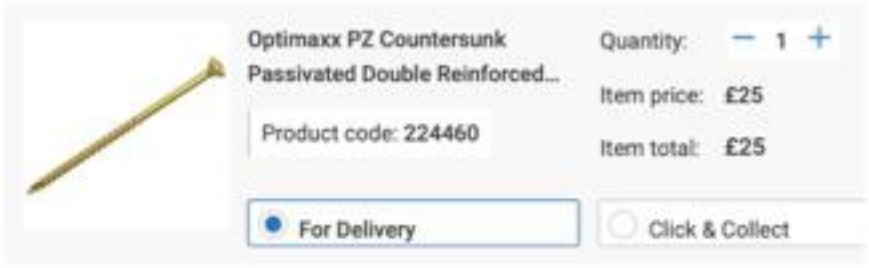
(£12.15 Per M2) (Wickes P5 Tongue and Groove Chipboard Flooring - 18 x 600 x 2400mm | Wickes.co.uk, 2022)

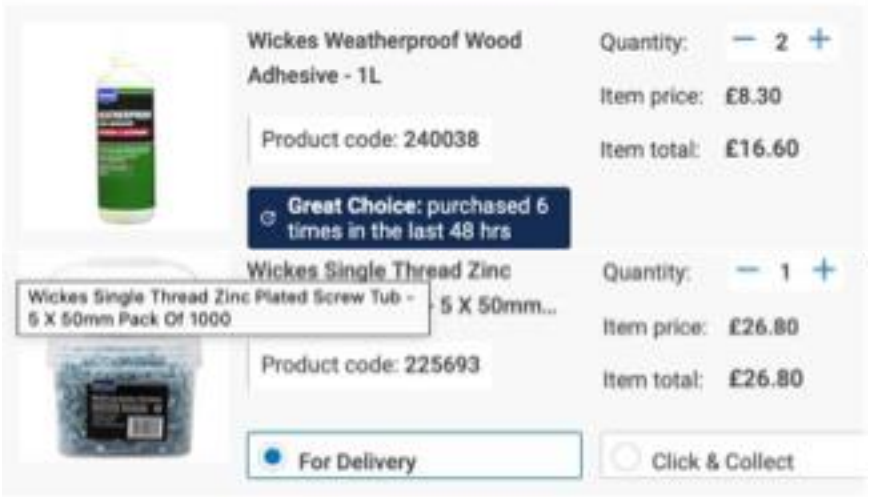
(Fillcrete Brickfill Expansion Joint Roll 10mm x 100mm x 10m, 2022) £15 per 10m

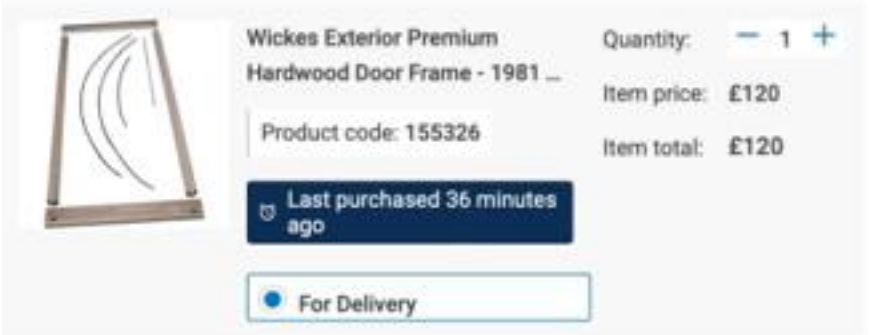
https://constructioncalcs.source4me.co.uk/calculators/standard/plaster-stud-wall.php

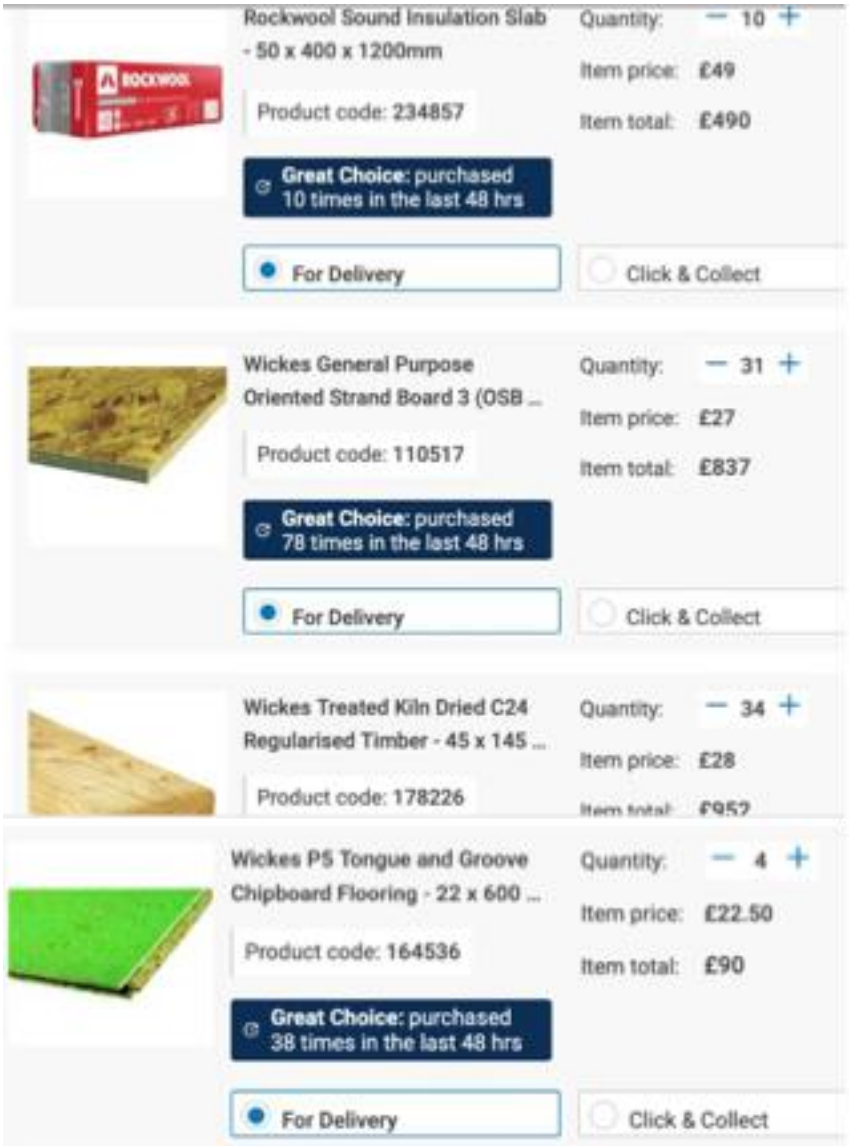
- Walls – 100 Linear metres of 4 x 2 (30m)
- 21x Sheets of 2400x1200mm chipboard. 735 screws
- 42x m2 insinuation
- Flooring 6m (2 layers)

Prices correct as of 28/12/2022 (wickes.co.uk)









Order Summary

Items subtotal:	£2,907.40
VAT:	£484.57
Free delivery ✓	
Total:	**£2,907.40**

(Price excludes airlock door catches, foam, and electrical products)