To: EGR Corporation
From: Jay Parmar, Tristan Perkins, Ari Posner, Ricky Nulman
Subject: Request for Design Analysis and Benchmarking Services
Date: January 30, 2024

Proposal Evaluation Board:
The purpose of this memo is to provide a response to your recent request to evaluate the construction materials, assembly details, and component cost associated with two particular alarm clocks available on the market.

Executive Summary:
This analysis is being performed to understand the construction of two mass-produced alarm clocks and provide insight on how to produce a more cost efficient and market-competitive clock design for EGR Corp. Our team dissected two consumer grade alarm clocks and recorded the materials used within each construction (see tables in Appendix 1 and 2), how it was assembled (via drawings on Figure 1 & 2 and Tables 1 & 2), along with an estimate of the cost of every component/subassembly (aforementioned Appendix sections). We concluded that the cost of the materials for the standard alarm clock was **$5.13**. The standard alarm clock has five major subassemblies; large plastic parts were the most expensive type of part in the clock. We propose to reduce the size of the standard clock, thereby improving its pragmatic and cosmetic appeal, as there is unnecessary empty space within the enclosure. We concluded that the cost of the materials associated with the vibrating alarm clock totals to **$8.25**, has five major subassemblies, and the most expensive type of component were those associated with electrical power delivery, vibration, and display. We propose reducing these costs by simplifying the LED screen type and changing the power delivery method.

Description of the approach:
The team decided to disassemble the components of the vibrating clock and standard clock in a similar order to compare the functions and structures of the two designs. We recorded materials by method of visual identification along the process of disassembly. Cost estimates were informed by referencing online mass-production component websites and recorded in the appendix. When taking apart each of the clocks we noticed that each one consisted mainly of two main sections. One of the sections was the main clock display components which consisted of an LED screen. The other side of the clocks was the circuits and the speaker systems in the alarm. The main difference we noticed between the two clocks is that the vibrating clock had a “Pod” attachment that would vibrate when the alarm would sound due to an offset counterweight. We also noticed when taking the alarms apart that the standard alarm clock used four circuit boards while the vibrating one used only 2 to connect the power to the vibrating module and the LED screen and speakers. Taking apart the alarm clocks gave our group a better understanding of how

the machinery functions. The specific steps of disassembly for each alarm clock are in figure 1 and 2 where you can see the exploded view of the clocks

Analysis Findings

Noticeable features:

The standard clock uses LED lights very effectively. The small LED lights are funneled into larger areas for both the screen and the snooze button. The large buttons make the clock easy to operate especially in the dark.

The most noticeable feature of the vibrating clock is the vibrating component of the alarm. Along with being woken up with noise your whole bed will vibrate causing you to wake up fast. Something that we found interesting was the simplicity of the vibrating component. It consisted of only one DC motor and 2 plastic hubs.

Proposal:

The vibrating clock uses a multicolor LCD time display that constantly changes colors when the clock is on. The use of this screen is both expensive and seemingly unnecessary as it makes the time more difficult to read, can be distracting in dark environments, and does not appear visually appealing based on our group's cosmetic analysis. The use of a traditional backlit digital LCD display would save on building expenses from around $2.00 to $0.50, saving approximately $1.50 as traditional backlit displays are more prevalent and less complicated from a design perspective. On the contrary, some users may prefer having the multi-color option, but we believe this is unlikely to be a major selling point for this design and that more profit will be made by reducing costs rather than retaining this feature.

The vibrating clock also employs a USB type C transformer and adapter. While USB-C technology offers advantages in power delivery efficiency and communication speed, it is overkill for an alarm clock and comes at a greater expense than necessary for this purpose. By switching this power delivery method to a standard 5/12VDC wall transformer or USB type A power delivery, the total price of the cable and transformer can be reduced by 50% from $1.50 to around $0.75 with no adverse performance tradeoff.

As for the standard clock, it lacks any major unique features that might be otherwise unnecessary and is very cost effective. The only thing we recommend is reducing the form factor of the clock by getting rid of some of the empty space within the enclosure, thereby making it smaller. This would allow the clock to take up less room on a desk or nightstand and increase its cosmetic appeal.

Costed Bill of Materials:

The front cover, PC screen, main body, button cover, and bottom cover take up 45.4% of the total cost of the standard alarm clock. Alone they cost 8.8%, 6.6%, 17.0%, 6.8%, and 6.2% of the total cost respectively. Overall, the costs for this clock are well balanced and lack substantial room for improvement. Trivial changes can be made to reduce the cost of the clock, but with little to no added benefit.

The LED display, USB-C transformer, and DC motor take up most of the total cost of the vibrating alarm clock. These components alone represent 60.5% of the total component cost, valued at 24.2%, 12.1%, and 24.2% respectively. This rationalizes the need to simplify the LED display and power delivery to substantially reduce overall costs. Small components, such as the screws and circuitry pieces, are individually cheap and collectively represent a much smaller portion of the overall cost; it is likely not worthwhile to reduce the expenses associated with these components.

The full components break down and their associated costs are available in appendix sections A and B.

Structured Assembly:

The following tables demonstrate the structured assembly of each alarm clock, which is a breakdown of each major subassembly and the notable components contained therein. This is illustrated in the two tables below:

Table 1: Standard Alarm Clock Structured Assembly

<table>
<tr><td></td><td colspan="3">←Assembly</td><td></td></tr>
<tr><td></td><td colspan="3">Disassembly→</td><td></td></tr>
<tr><td rowspan="6"></td><td rowspan="6"></td><td colspan="2">External Screws (4)</td><td rowspan="6"></td></tr>
<tr><td rowspan="3">Front Cover</td><td>PC Screen</td></tr>
<tr><td>Speaker</td></tr>
<tr><td>Speaker Cover</td></tr>
<tr><td rowspan="2">Main Body</td><td>Screws (5)</td></tr>
<tr><td>LED Display</td></tr>
</table>

Assembly Level	Standard Clock		Circuit Board	Part Level
			Standoffs (4)	
			Washer	
			Cord Holder Screw	
			Transformer	
		Circuit Board	Plastic Frame	
			Buttons (6)	
			Capacitor	
			Inductor	
		Plastic Frame	Snooze Button	
			Switches (2)	
			4-Button Piece	
		Battery Case	Screws(4)	
			Battery Cover	
			Battery Holder	
		Ribbon Cable		
		Power Cord		

Table 2: Vibrating Alarm Clock Structured Assembly

	←Assembly			
	Disassembly→			
		External	USB-C Transformer	
			USB-C to DC Cable	
			Battery Cover	
			Snooze Plastic Button	

Assembly Level	Vibrating Clock	Top Enclosure	Hour Plastic Button Cover	Part Level
			Min Plastic Button Cover	
			Snooze/Light Plastic Button Cover	
			LED Plastic Housing (White)	
			White LED	
			LED PCB	
			3 Wire Cable	
			(Black) Plastic Button Holder	
			Snooze/Hour PCB	
			Snooze/Hour Push Buttons	
			Micro Screws	
		Main Circuit Board	Push Button	
			Three Position Switch	
			Resistor	
			Ribbon cable	
			Alarm Speaker	
			USB Port	
			DC Port	
		Display Unit	LED Display	
			LCD Screws (4)	
Assembly			Plastic Screen Housing	

Level (continued)	Vibrating Clock		Clear Screen Cover	Part Level
			LCD Circuit Board Screws (4)	
			Back Plastic Cover	
			Black Buttons (4)	
			Red Buttons	
		Vibrating Unit	Round Cover (2)	
			DC Motor/Hub	
			Case Screws (4)	

Table 2 (Continued)

Exploded Assembly Sketches

The following sketches demonstrate the assembly construction of each alarm clock at the component and sub-assembly level:

Standard Alarm Clock

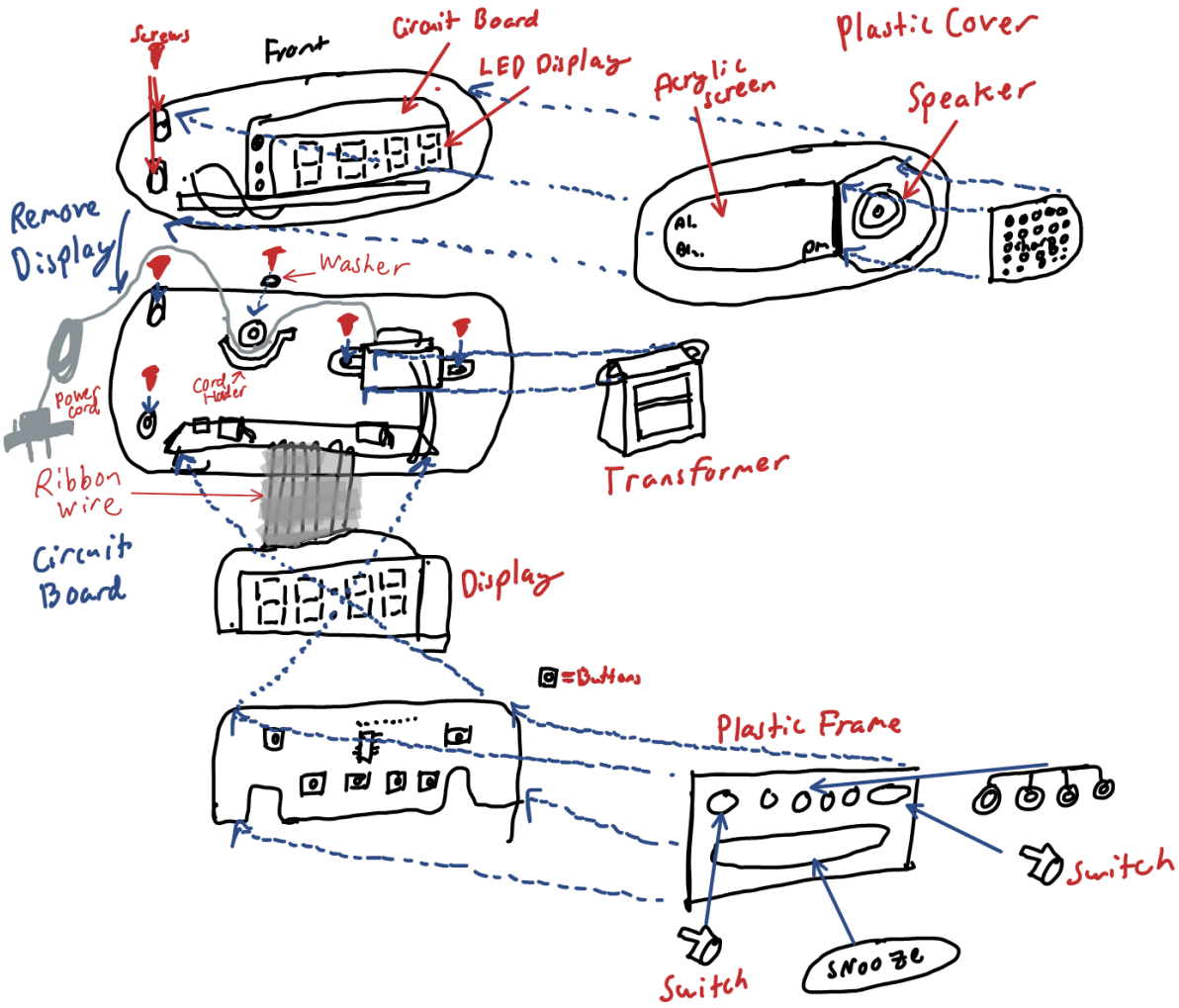

Figure 1 : Part Details for Clock 1

Vibrating Clock

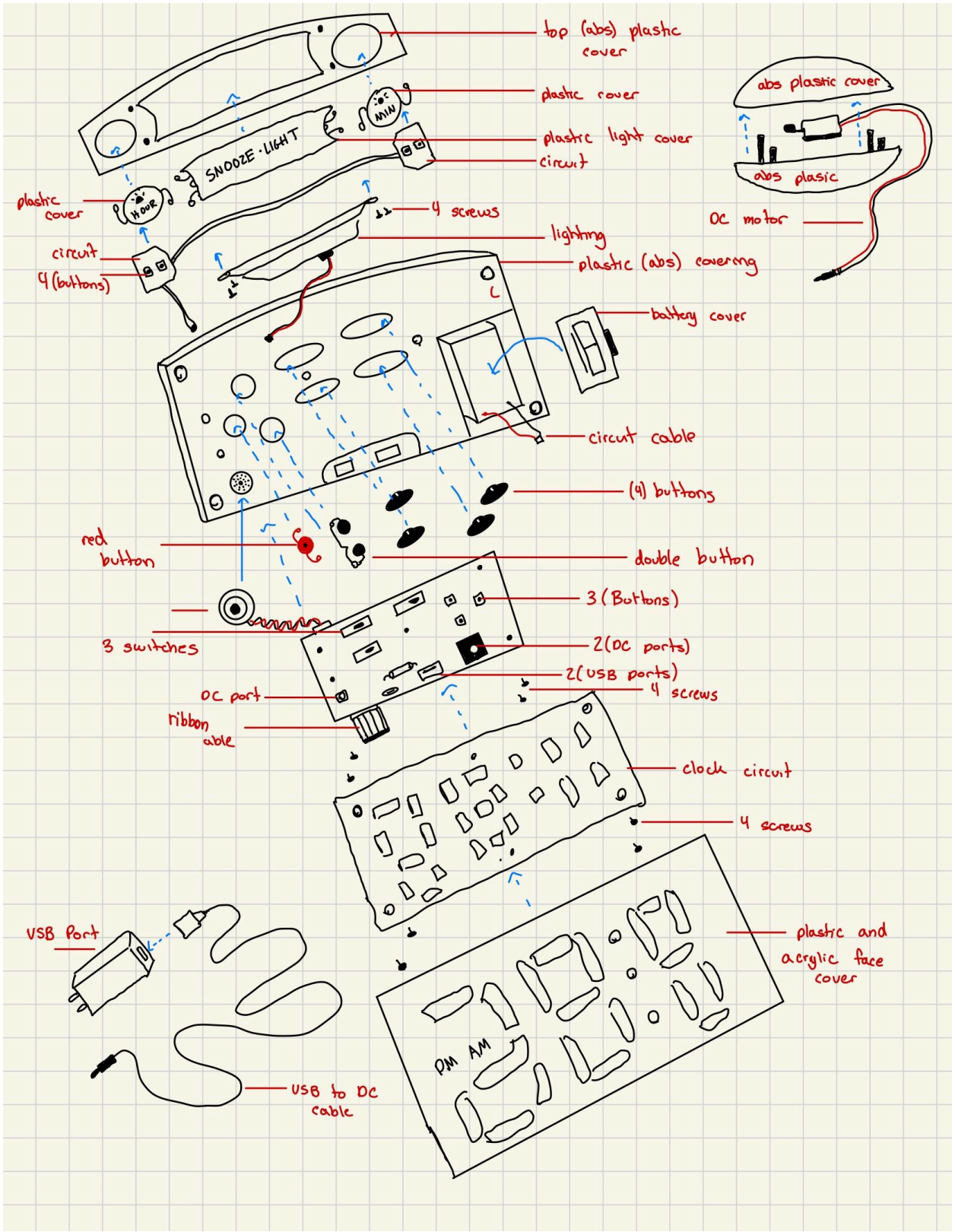

Figure 2: Part Details for Clock 2

Summary and Conclusion:

To analyze the clock appliance market, we fully disassembled the standard alarm clock and the vibrating alarm clock. From our analysis, we recommend replacing the Viberingating clock screen with a simpler screen and removing the cable and transformer from the standard clock. These changes will reduce the cost of production from approximately $5.13 to $4.38 (Table 1) for the standard clock and from approximately $8.25 to $6.25 (Table 2) for the flying clock. Overall our group thinks that these changes will not hinder the design of the clocks but will make them more affordable for more people.

Appendix A: **Table of Materials for Standard Clock**

| Front Cover | Main Body | Circuit Board | Plastic Frame | Battery Case | Other |

Part Number	Part Name	Material	Qty	Est. Part Cost ($)	Est. Total Cost ($)
1	Front Cover	PS Plastic	1	0.45	0.45
2	Speaker Cover	PS Plastic	1	0.10	0.10
3	Speaker	N/A	1	0.11	0.11
4	PC Screen	PC Plastic	1	0.34	0.34
5	Cord Holder Screw	Steel	1	0.02	0.02
6	Standoffs	PS Plastic	4	0.03	0.12
7	Main Body	PS Plastic	1	0.87	0.87
8	Washer	PS Plastic	1	0.01	0.01
9	Additional Screws	Steel	5	0.02	0.10
10	LED Display	N/A	1	0.30	0.30
11	Transformer	N/A	1	0.38	0.38
12	Inductor	N/A	1	0.06	0.06
13	Capacitor	N/A	1	0.03	0.03
14	Circuit Board	N/A	1	0.30	0.30
15	Buttons	N/A	6	0.05	0.30
16	Switches	PS Plastic	2	0.05	0.10
17	Snooze Button	PS Plastic	1	0.11	0.11
18	4 Button Piece	PS Plastic	1	0.07	0.07
19	Button Cover	PS Plastic	1	0.35	0.35
20	Bottom Cover	PS Plastic	1	0.32	0.32
21	Battery Holder	N/A	1	0.05	0.05

22	Battery Cover	PS Plastic	1	0.13	0.13
23	Electronic Screw	Steel	4	0.02	0.08
24	Ribbon Cable	N/A	1	0.07	0.07
25	Power Cord	N/A	1	0.28	0.28
26	External Screws	Steel	4	0.02	0.08
-	****TOTAL****	-	**45**	-	**$5.13**

Appendix B: Table of Materials for Vibrating Alarm Clock

| External | Vibrating Unit | Display Unit | Main Circuit Board | Top Enclosure |

Part #	Part Name	Material	Qty	Est. Cost ($)	Est. Total Cost ($)
1	USB-C Wall Transformer	ABS + Copper Internals	1	$1.00	$1.00
2	USB-C to DC Cable	Rubber + Copper Internals	1	$0.25	$0.25
3	Plastic Battery Cover	ABS	1	$0.03	$0.03
4	Round Plastic Cover	ABS	2	$0.05	$0.10
5	DC Motor with Imbalanced Metal Hub	Steel	1	$2.00	$2.00
6	Outside screws	Stainless Steel	4	$0.01	$0.04
7	Clock LED Display	LED/Plastics	1	$2.00	$2.00
8	Clock Micro LCD Screws	Stainless Steel	6	$0.01	$0.06
9	Clock Plastic Screen	ABS	2	$0.25	$0.50
10	Plastic Clear Screen	Acrylic	1	$0.20	$0.20

11	Main Circuit Board Screws	Stainless Steel	5	$0.01	$0.05
12	Back Plastic Cover	ABS	1	$0.70	$0.70
13	Black Buttons	ABS	4	$0.05	$0.20
14	Red Buttons	ABS	2	$0.05	$0.10
15	Push Button	Copper + Polycarbonate	3	$0.03	$0.09
16	Three Position Switch	Copper + Polycarbonate	3	$0.04	$0.12
17	Resistor	Carbon + Ceramic	1	$0.01	$0.01
18	Ribbon cable	Copper + Rubber	1	$0.03	$0.03
19	Alarm Speaker	ABS + Copper + Steel	1	$0.05	$0.05
20	USB Port	ABS + Steel	2	$0.02	$0.04
21	DC Port	ABS + Steel	2	$0.02	$0.04
22	Snooze Plastic Button	ABS	1	$0.02	$0.02
23	Hour Plastic Button Cover	ABS	1	$0.02	$0.02
24	Min Plastic Button Cover	ABS	1	$0.02	$0.02
25	Snooze/Light Plastic Button Cover	ABS	1	$0.05	$0.05
26	LED Plastic Housing (White)	ABS	1	$0.03	$0.03
27	White LED	Steel + Gallium Arsenide	1	$0.09	$0.09
28	LED PCB	Copper + Resin	1	$0.05	$0.05

29	3 Wire Cable	Copper + Rubber	3	$0.03	$0.09
30	(Black) Plastic Button Holder	ABS	1	$0.02	$0.02
31	Snooze/Hour PCB	Copper + Resin	1	$0.05	$0.05
32	Snooze/Hour Push Buttons	ABS	4	$0.04	$0.16
33	Micro Screws	Stainless Steel	4	$0.01	$0.04
-	****TOTAL****	-	**64**	-	**$8.25**