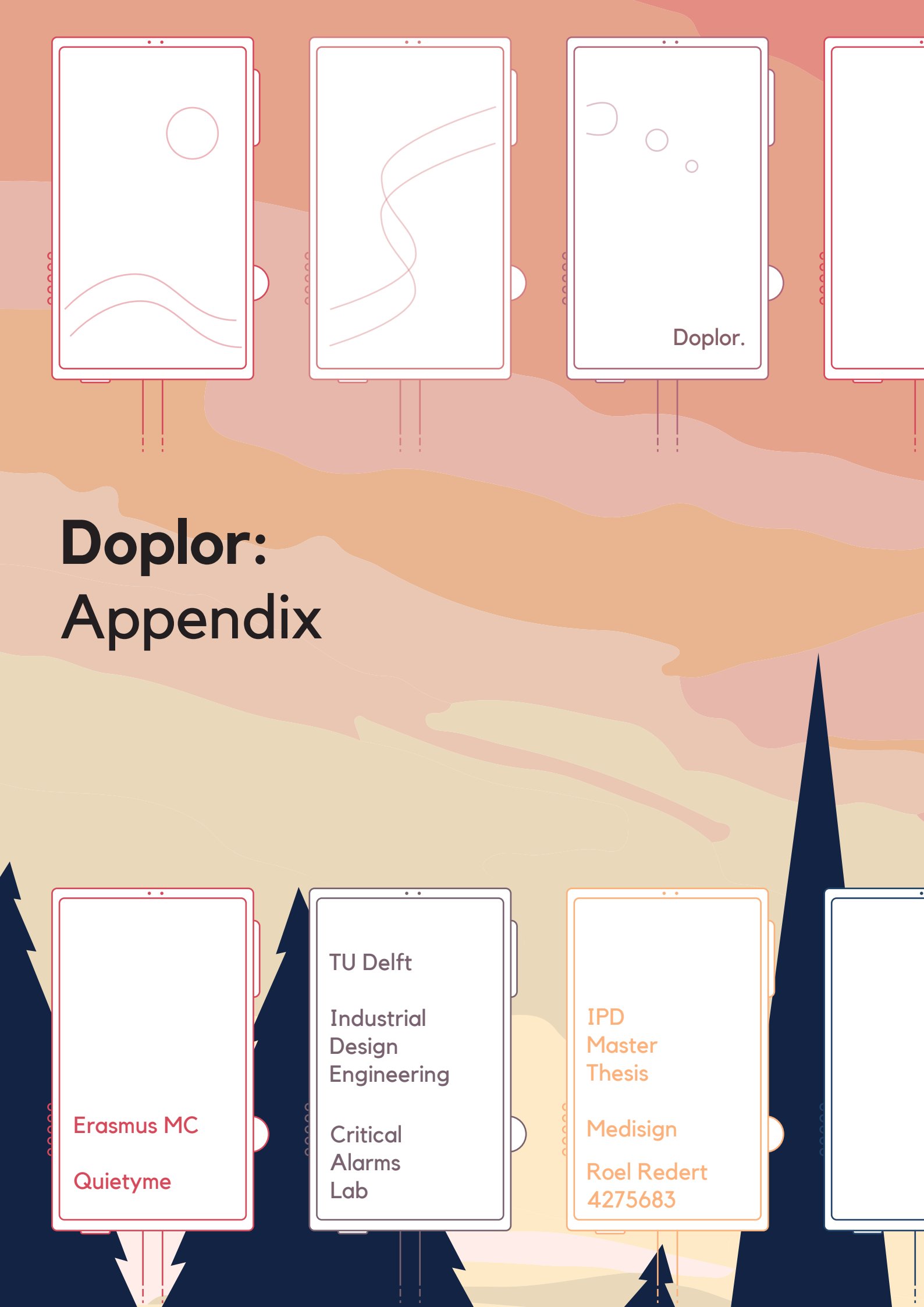

Doplor: Appendix

Erasmus MC

Quietyme

TU Delft

Industrial Design Engineering

Critical Alarms Lab

IPD Master Thesis

Medisign

Roel Redert
4275683

Appendix:

A0 • Signed Project Brief

Appendices referred from ch 1
A1 • Sleep research: Quietyme
A2 • Meeting 4 - Nurse C
A3 • Meeting 3 - Pedeatric ICU doctor
A4 • Patient Journey

Appendices referred from ch 2
A5 • Meeting 1 - Nurse A
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Appendices referred from ch 3
A10 • Research 1: How-to booklets
A11 • Morphological chart ideas
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A13 • Research 2 : Respondent form

Appendices referred from ch 4
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A15 • Research 3 : Video snaps

Appendices referred from ch 5
A16 • Texts over visuals
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Appendices referred from ch 6
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A19 • Electrical flowchart
A20 • Research 4 : Respondent form
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A22 • Screenshots cost calculation

A1. Sleep research: Quietyme

13-Apr								amount of alarms					
entity_name	hour	qtscore	sleepcycles	dist	percentquiet	max_lev	min_lev	nt_alarm	nt_alarm_duration	nt_spike	nt_spike_duration	nt_talking	nt_talking_duration
H307	0	0	0	0	100	66	34,5	0	0	0	0	0	0
H307	1	47	0	0	99	71,5	34,5	0	0	0	0	0	0
H307	2	0	0	0	100	61	34,5	0	0	0	0	0	0
H307	3	4	0	0	100	67,5	34,5	0	0	0	0	0	0
H307	4	0	0	0	100	56,5	35	0	0	0	0	0	0
H307	5	0	0	0	100	64	35	2	8	45	135	3	213
H307	6	23	0	1	100	71	35	0	0	45	137	7	222
H307	7	32	1	2	99	71	34,5	1	5	37	111	5	282
H307	8	2	0	0	100	67	35	3	25	36	108	7	254
H307	9	15	0	1	100	72,5	35	5	39	124	372	11	800
H307	10	170	0	8	97	73,5	35	44	233	125	375	28	2597
H307	11	80	0	2	99	74,5	35,5	40	272	58	174	41	2204
H307	12	33	0	1	100	77,5	35	58	345	136	408	36	2678
H307	13	94	0	5	98	75,5	35	22	109	151	453	32	2111
H307	14	80	0	4	99	75,5	35	20	104	171	516	30	2419
H307	15	382	0	15	93	74,5	35	18	100	120	361	29	3292
H307	16	55	0	1	99	71,5	34,5	9	55	65	195	17	906
H307	17	11	0	1	100	72	35	1	7	29	88	7	267
H307	18	13	0	0	100	72,5	34,5	0	0	0	0	0	0
H307	19	5	0	0	100	70,5	34,5	0	0	0	0	0	0
H307	20	71	0	0	99	74,5	34,5	0	0	0	0	0	0
H307	21	13	0	0	100	69,5	34,5	0	0	0	0	0	0
H307	22	9	0	0	100	71,5	34,5	0	0	0	0	0	0
H307	23	46	0	0	99	68,5	34,5	0	0	0	0	0	0

14-Apr													
entity_name	hour	qtscore	sleepcycles	dist	percentquiet	max_lev	min_lev	nt_alarm	nt_alarm_duration	nt_spike	nt_spike_duration	nt_talking	nt_talking_duration
H307	0	5	1	0	100	70,5	34,5	4	22	39	117	8	274
H307	1	3	1	0	100	69	34,5	2	10	48	144	1	251
H307	2	4	0	0	100	72	34,5	1	5	12	36	3	82
H307	3	1	1	0	100	66,5	34,5	0	0	75	225	4	575
H307	4	0	1	0	100	64,5	34,5	1	4	29	87	2	100
H307	5	15	0	0	100	72,5	35	6	30	48	143	13	555
H307	6	0	1	0	100	64,5	35	0	0	7	21	2	45
H307	7	0	0	0	100	62,5	35	1	5	201	601	10	792
H307	8	10	0	1	100	69	35	7	32	91	273	12	660
H307	9	52	0	4	99	72	35	18	88	140	420	36	2079
H307	10	1	1	0	100	66,5	35	5	22	199	598	13	1086
H307	11	44	0	4	99	74	35	9	39	139	419	27	1562
H307	12	150	0	8	96	74	35	22	102	131	395	42	2953
H307	13	20	0	2	100	71,5	35	7	34	133	399	20	1297
H307	14	74	0	3	99	72	35	10	47	78	234	24	1319
H307	15	3	1	0	100	69,5	35	2	12	102	306	6	597
H307	16	28	0	2	99	70,5	35	15	68	90	275	20	966
H307	17	106	0	6	98	73,5	35	8	44	68	205	14	1077
H307	18	32	0	2	100	73	35	1	18	52	156	7	1027
H307	19	82	0	3	99	82	35	9	42	139	419	28	1393
H307	20	43	0	3	99	71,5	35,5	2	8	103	309	11	561
H307	21	121	0	5	98	74	34,5	5	22	58	174	16	993
H307	22	0	1	0	100	58	35	1	4	5	15	0	0
H307	23	112	0	1	99	73,5	34,5	7	56	64	193	13	660

15-Apr													
entity_name	hour	qtscore	sleepcycles	dist	percentquiet	max_lev	min_lev	nt_alarm	nt_alarm_duration	nt_spike	nt_spike_duration	nt_talking	nt_talking_duration
H307	0	0	0	0	100	63,5	35	1	5	4	12	0	0
H307	1	0	1	0	100	62	35	2	8	8	24	0	0
H307	2	7	1	0	100	71	35	0	0	159	477	3	580
H307	3	53	0	2	99	66,5	35	0	0	220	660	2	1045
H307	4	73	0	1	98	69	35	3	13	209	630	11	915
H307	5	7	1	0	100	71,5	35	0	0	39	118	4	272
H307	6	0	1	0	100	61,5	35	0	0	16	48	2	78
H307	7	0	0	0	100	64,5	35	2	8	30	90	3	190
H307	8	16	0	1	100	74,5	35	4	19	85	253	20	1023
H307	9	34	0	1	99	71,5	35	22	145	150	449	33	1835
H307	10	5	1	0	100	72,5	35	8	41	135	404	19	761
H307	11	54	0	3	99	75	34,5	18	86	173	519	29	1913
H307	12	100	0	8	98	72	35	21	105	158	476	39	2862
H307	13	60	0	8	98	69,5	35	11	53	126	379	26	2213
H307	14	20	1	0	100	71	35	11	79	76	227	19	878
H307	15	45	0	3	99	73,5	35	6	33	97	290	27	1187
H307	16	7	1	1	100	68,5	35	11	56	76	228	16	926
H307	17	61	0	1	99	74	35	7	41	152	459	12	970
H307	18	3	0	0	100	70,5	35	2	8	21	63	3	124
H307	19	146	0	7	98	75	34,5	8	45	80	240	23	1427
H307	20	5	0	0	100	71	34,5	1	5	7	21	2	81
H307	21	72	0	6	99	73,5	34,5	6	31	86	258	19	1044
H307	22	0	1	0	100	63	34,5	1	4	81	244	2	332
H307	23	5	1	0	100	70	34,5	3	12	84	252	6	431

16-Apr													
entity_name	hour	qtscore	sleepcycles	dist	percentquiet	max_lev	min_lev	nt_alarm	nt_alarm_duration	nt_spike	nt_spike_duration	nt_talking	nt_talking_duration
H307	0	5	0	0	100	67,5	35	3	15	14	42	2	156
H307	1	14	1	0	100	72,5	35	3	13	84	253	6	455
H307	2	36	0	3	99	75,5	35	4	18	47	141	11	532
H307	3	31	0	1	100	75,5	35	3	13	69	207	5	476
H307	4	0	1	0	100	61,5	35	0	0	11	33	1	17
H307	5	17	0	2	99	68,5	35	2	9	72	216	8	503
H307	6	7	1	0	100	70,5	35	6	123	50	150	9	352
H307	7	11	0	0	100	69	35	2	23	16	48	5	411
H307	8	63	0	2	99	74	35	3	16	88	264	14	738
H307	9	73	0	3	98	71,5	35	10	56	113	339	25	1976
H307	10	39	0	1	99	71	35	4	18	148	447	20	1119
H307	11	5	1	1	100	69,5	35	11	75	107	321	23	1186
H307	12	24	0	0	100	73,5	35	7	34	73	222	10	597
H307	13	79	0	6	99	74	35	9	58	143	429	18	1975
H307	14	58	0	3	99	74	35	5	23	51	153	13	583
H307	15	26	0	1	99	72	35	31	212	79	238	12	1522
H307	16	183	0	3	94	73,5	35	11	96	74	223	11	675
H307	17	442	0	14	90	75	34,5	9	67	168	503	22	2132
H307	18	106	0	8	98	75	35	5	24	86	257	17	1308
H307	19	56	0	3	99	73	35	6	30	92	276	24	1238
H307	20	12	0	0	100	71,5	35	1	14	17	51	6	195
H307	21	48	0	2	99	75	35	4	26	34	101	8	412
H307	22	43	0	3	99	72	35	25	123	24	72	24	1001
H307	23	28	1	1	99	71,5	35	7	37	34	102	7	357

17-Apr													
entity_name	hour	qtscore	sleepcycles	dist	percentquiet	max_lev	min_lev	nt_alarm	nt_alarm_duration	nt_spike	nt_spike_duration	nt_talking	nt_talking_duration
H307	0	46	0	4	98	66,5	35	2	9	63	189	5	296
H307	1	83	0	2	98	69,5	35	1	4	37	112	3	245
H307	2	72	0	4	98	71	35	8	61	68	205	12	667
H307	3	403	0	6	91	69,5	35	5	23	32	98	12	531
H307	4	11	0	1	100	68,5	34,5	0	0	12	36	1	83
H307	5	84	0	2	97	72	35	0	0	87	261	4	450
H307	6	10	0	2	99	64	35	3	23	37	111	6	295
H307	7	23	0	2	98	71,5	35	11	63	25	75	5	407
H307	8	348	0	13	94	74	35	6	30	82	247	21	838
H307	9	375	0	14	89	83,5	35	11	52	89	267	22	1576
H307	10	249	0	16	91	73	35	13	63	98	297	33	1779
H307	11	184	0	19	93	72,5	35	12	67	69	207	29	1554
H307	12	213	0	6	93	71,5	35	7	40	111	333	19	1085
H307	13	70	0	3	90	74,5	35	4	21	449	1347	12	2115
H307	14	383	0	20	87	72	35	13	61	151	454	26	2064
H307	15	97	0	17	95	71	34,5	12	58	284	852	26	2409
H307	16	44	0	3	99	72	35	2	9	13	39	3	182
H307	17	137	0	8	96	72	35	6	28	133	400	18	1492
H307	18	119	0	10	93	72	34,5	25	167	190	572	10	1518
H307	19	290	0	9	90	72	35	17	99	105	316	18	1761
H307	20	197	0	7	93	72,5	35	6	95	45	136	7	363
H307	21	143	0	7	91	71,5	35	3	85	144	432	9	1103
H307	22	44	0	5	98	72,5	35	2	10	83	249	4	402
H307	23	11	0	2	99	66,5	35	1	5	64	192	2	343

18-Apr													
entity_name	hour	qtscore	sleepcycles	dist	percentquiet	max_lev	min_lev	nt_alarm	nt_alarm_duration	nt_spike	nt_spike_duration	nt_talking	nt_talking_duration
H307	0	13	1	1	99	67,5	35	3	15	53	159	9	328
H307	1	13	0	0	100	69,5	35	3	13	23	68	5	226
H307	2	173	0	6	97	75	35	4	18	42	127	6	312
H307	3	68	0	4	98	71	35	3	17	34	104	6	335
H307	4	10	0	1	99	66,5	35	0	0	35	104	3	191
H307	5	13	0	1	99	66	35	4	20	29	87	5	250
H307	6	42	0	3	98	67,5	35	5	21	96	286	13	682
H307	7	31	0	3	99	69	35	7	34	21	65	8	361
H307	8	162	0	11	93	75,5	35	22	106	104	312	35	1680
H307	9	82	0	2	99	75,5	35	2	10	36	108	3	114
H307	10	167	0	6	96	75	35,5	7	34	64	193	16	792
H307	11	354	0	15	89	74	35	21	99	86	258	31	1641
H307	12	31	0	1	99	72	35	2	10	14	43	2	146
H307	13	584	0	25	81	71,5	35	23	114	190	571	36	3260
H307	14	325	0	9	91	74,5	35	14	77	53	160	12	1179
H307	15	264	0	21	90	74,5	35	21	122	187	561	28	2726
H307	16	99	0	7	97	71	35	3	13	102	306	7	803
H307	17	261	0	10	94	74	35	8	35	47	144	17	685
H307	18	194	0	1	96	78	35	5	23	35	105	8	406
H307	19	213	0	5	96	76	35	7	51	45	135	15	565
H307	20	27	0	1	99	71	35	0	0	43	129	6	249
H307	21	35	0	2	98	66,5	35	6	30	18	54	5	365
H307	22	1	1	0	100	62,5	35	1	4	3	9	0	0
H307	23	231	0	5	98	73,5	35	4	19	29	87	9	366

A2. Meeting 4 - Nurse C

Different patients have different needs and illnesses. Some people stay only one or two nights at the IC, others are there for 5 or 6 weeks.

When patients are asleep their blood pressure drops. This can be acted on with alarms but this happens too little with nurses. However, the nurse needs to be very confident that she knows why she is lowering the alarm limits. Someone with an illness in or close to his brain, has a need for a lower blood pressure close to 70.

People with neuro-related problems are being sedated, which means that there is a very close eye kept on them anyway. The system should work, or at leas if it would work, with sedated people different from that of other patients.

Another distinction between patients is how stable they are regarding alarms. Some people have a stability of near 24 hours, and only some alarms initiate when they move when they are being washed. People going for a thuisbeademing system are only i the Intensive Care for one ore two days, they are not very much affected by all alarms and only stay short so it is not such a problem if they are visited multiple times. For most people it is maximum tolerated to decrease 5mmHg, given that urine production of the patient remains normal.

Very little nurses are giving the proper rest in the afternoon. After lunch is a great time to plan a little break. Bear in mind that patients should not sleep the whole day, because then they will not be able to sleep properly in the night. And sleep during the night is always deemed more important that sleep during the day, link to circadian cycle.

Sometimes, when a patient is sedated the blood pressure is flowing from the left to the right and a lot of other things are happening. I such a case it is more important to see that the patient stays alive instead of being too loud.

The morning is very exhausting for patients, it feels for them as if they are running the marathon. Then they undergo either scans, surgery, or whatever treatment. But then after lunch they should be given the opportunity to rest for 1 to 1,5 hour (a sleep cycle long, woken in the second cycle second stage).

Even though Nurse C stated that she tends to speak to nurses and doctors when they are behaving too loud, she also noted that a lot of nurses do not (dare to) do this. Leading to sometimes very loud conversations or laughs, actually unsuitable for an hospital environment.

From the three design directions that were shown to Nurse C, she expected either the mobile or the static reminders were more feasible than an improved alarm management. This might be because the example that I gave (being able to shut down an alarm through voice recognition) was perceived a bit negative. You would still add sound through behaviour, saying something like 'shut down alarm' would still cause noise pollution.

Nurse C thought that having a reminder on the floor could help in letting nurses, doctors and everybody else visiting the IC, when noise levels are high or have been high over the past time. The product should notify 'users' also especially when patients are asleep.

A3. Meeting 3 - Pedeatric ICU doctor

Oversight is lacking in single patient rooms
When being a nurse within an ICU, or NICU/PICU, the amounts of alarms sent through to a pager should be sensible. The alarms should be sent in such a way that only very urgent ones are sent through. More than 10 alarms an hour is too much.

It was shown that 97% of all alarms that ring do not have to be directly acted upon, making only 3% of the alarms the actual urgent ones. There are already devices (screens) by Philips that make it possible to set which alarms to forward to the nurse, and which ones to not forward. This makes the nurse more effective, it should be noted though that when an alarm isn't forwarded, it still rings at the bedside of the patient, and therefore this solution is definitely not optimal.

When looking at alarms, there are two types (figure X). Alarms within the yellow zone, and alarms within the red zone. Often are the alarms within the yellow zone not life threatening and often they cannot directly be acted on. These yellow alarms are only to attend the nurse of the current state, and is therefore in many cases unnecessary. It is due to the FDA that these alarms are there, but in some cases it is possible to extend the alarm limits, making it initiate less frequent.

Once again, in this hospital it became clear that there is a legal standard that there should be an alarm in the room of the patient. It seems that still machines are dictating alarms, while people should actually have the overhand.

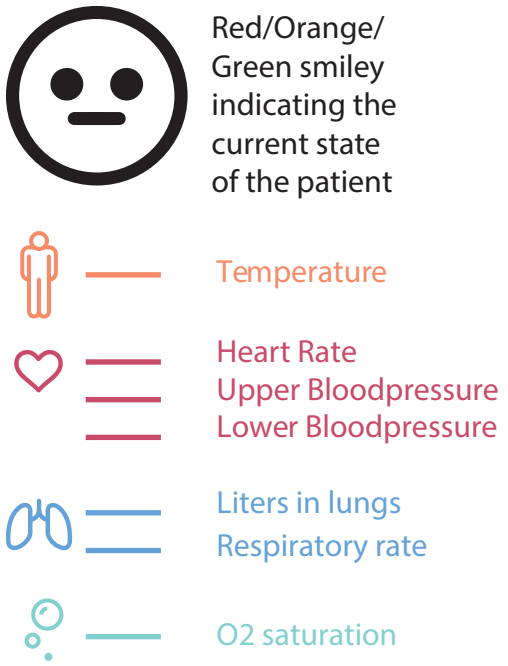
A question arose: Do nurses want the same information as doctors? Doctor A expected not. Nurses are more interested in the information of directly now, is there something I can do right away (for example giving some medicine or dismissing an alarm). Doctors are more interested in the health trends, so whether for example the blood pressure has dropped the past three days. Here the difference becomes clear that nurses are for caring and doctors are for curing.

They had already performed a test in which only very limited information was shown (see figure A1), and none of the nurses complained that they had too little information. This shows that Doctor A is probably right, and that nurses only need information which is of current importance.

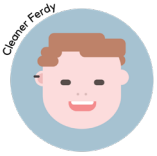
Lastly, especially when there is less overview within an IC because all rooms are one-person rooms, it is necessary to have a map with all rooms and numbers, indicating what the state of the patient is or what sort of alarm is going off. Without this map, the workflow would be much more inefficient as it is not completely clear what needs to be done in which room.

Figure A1

According to Ped. ICU. doc. (2018) all necessary information for nurses could be found in the following factors. More information would only be necessary when treatment is performed.



A4. Patient Journey

	7:45	8:00	8:20	8:45	9:00 - 10:00
	Start of the day, light automatically turn on. The night shift is performing the transfer to the morning shift.	Kickstart of the day is finished. Breakfast is served, nurses have their patients assigned.	Nurses have a meeting on what treatments will be performed today. Some nurses disagree with eachother.	It is time to clean the patients. Plates are collected by Eva and Anna made a call for Chris, to install a mechanical ventilator.	Treatments are given to persons who need them. As patients move sensors shift, causing alarms to initiate about every 10 minutes.
 Nurse Anna	Anna and Bob are performing the transfer of patients. They try to dismiss Desies alarm but it initiates immedeately again. They leave the alarm ringing.	Anna will be aring for Desie today. She enters her ICU and greets her a good morning.	Anna is heavily discussing with Bob whether the treatment of Desie should continue. They are both quite agitated.	Anna goes to Desie and washes her and talks a bit to her.	Anna is performing a salt-water treatments on Desie and is moving some cables at Desie's bedside. When finished she returns to the nurse post.
 Nurse Bob			Bob stops the discussion and leaves for his own patient.	Bobs patient already washed himself so he returns to the nurse post to make a report about the patient his health status.	Bob is constantly surrounded by alarms which are not for him. He looks a few times and becomes deaf to them.
 Surgeon Chris				Chris recieves Anna's call and schedules a meeting later today.	
 Patient Desie	Desie awakens and moves in her bed. Her SPO2 clip falls of her finger and the first alarm initiates.	Desie greets Eva and she starts munching away on her breakfast.		Desie is being refreshed by Anna. She gets informed about the procedure that will happen in the afternoon.	
	Neutral	Slightly frustrated	Comfortable	Ashamed	Scared
 Assistant nurse Eva	Eva is in the kitchen receiving the breakfasts from the elevator. She puts all on plates.	Eva brings the plate with breakfast to Desie. She also greets desie and she replaces the sensor on her finger.			Eva is talking with the other nurses about her weekend. All laug rigorously.
 Cleaner Ferdy		Ferdy walks through the corridor and accidentally a crate falls of his cart. He yells 'nothing wrong' and continues.	Ferdy empties the bins at the nurse posts and then starts mopping and cleaning all toilets.	Ferdy grabs his cart and movesto the toilets on other floors.	
 Visitor Gena					Gena is on her way to work and decides to pay a visit to Desie before she goes to her work.

10:30	10:55	11:20	11:40	12:00	12:20
From now visitors have free access to the ICU. Some treatmens continue but Desie is done for now.	A new patient is rushed into the ICU on a bed. He becomes the patient of Bob. The patient needs a total of 7 pumps.	Chris arrives with his tools at Desie. The first half of the nurses go on a break.	All pagers still ring each minute with an emergency signal. There is much sound pollution on the whole IC.	Installing the ventilator is finally finished.	Ferdy is finished with cleaning the IIC.
	Anna joins in the new ICU to help the new patent attach to all pumps. She completely misses the alarm of Desie ringing at the nurse post.	Anna goes on a break and leaves her pager on the esk of the nurse post. She aasks Eva to look over Desie a bit while on her break.		Anna returns from her berak and pays a visit to Desie. She dismisses multiple times the alarm but is aware the ventilator causes it. She alters the limits.	Anna is too busy to continuously be at Desies bed so she sometimes dismisses the alarm but does not find the opportunity to change the limit.
	Bob rushes through the IC to get all pumps. He makes a lot of noise with the cart on which all pumps are placed.	Bob returns to the nurse post and gets notified he has a late break today.	Bob gets inane of all pagers and finally decides to check up on Desies room and turns off the alarms and thus all the pagers.	Bob goes for a break now. Anna will watch over his tow patients as well.	
	Chris is preparing all tools he needs and is on his way to the IC.	Chris starts with the inturbation of Desie but forgets to turn off the alarms. When he unplugs a tube all pagers get emergency notifications, but Chris does not notice.	Chris is very focussed and does not even notice in the beginning. Later, as Bob tells him, he understands he should have turned off the alarms.	Chris turns on the alarms again but does not change the alarm limits, then he leaves again.	
The sight of Gena and the loud bang increase Desie's heartrate. An alarm starts ringing.	Desie was dozing off but got scared by all sounds and rushing people. Multiple alarms go off but she does not know which. The alarms prevent her from sleeping.	Desie undergoes the inturbation process.		Desie is exhausted but it is impossible to get into sleep with Ferdy in her ICU. Alarms go off continuously due to the unchanged limits.	Desie starts dosing off again, but as her blood pressure constantly drops a little, alarms keep on initiating. Sleeping realy becomes a problem and remains very light.
Enthausiastic, Frustrated	Comfortable	Scared		Tired, Exhausted	Frustrated and exhausted
Eva walks by with a cart full with crates. 10 of them fall giving a loud bang.		Eva goes to the medication room to prepare all of todays medications and brings them to the patients.			
				Ferdy opens the door of Desie's ICU and starts mopping the floor with bleach.	Ferdy leaves with his cart again.
Gena comes into Desies ICU and hugs her. She is afraid something is wrong as the alarm initiates. She catches up a bit and leaves at 10:50.					

MOOC patient journey

Practical challenge | Module 4

Use the Journey Map you created last week to start a design project with its insights. Fill the following templates to achieve it.

Indentify friction

Step 1: Use the patient journeys you made to identify possible friction points for innovation.

Step 2: Describe three of the problems you identified. Fill in the problem, the cause and the relevance of solving this problem.

Problem I:
The problem is noise pollution in the intensive care
This is caused by alarms, speech, background noise and incidental sounds
This is a relevant problem because patients recover less efficient when in the ICU. Sound quality is poor

Problem II:
The problem is alarm fatique in the nurse
This is caused by too much (irrelevant) alarms going off in different ICU's
This is a relevant problem because this fatique makes patients recover less effective

Problem III:
The problem is sensors moving initiating alarms
This is caused by patients moving and sensors detatching
This is a relevant problem because all alarms start to ring as measurements are faulty

Choosing your battle

Step 3: Make a choice which friction point or problem you would like to solve.

My choice is problem I/~~XXXXXX~~ because alarm fatique can be tackled if sound pollution is less and buying other sensors also greatly improves quality.

Set a design goal

Step 4: Define a design goal.

Example: to develop a product/service to reduce pre-surgery anxiety

"My design goal is to create a product that helps nurses see what is contributing most to the sound pollution in the IC."

Define the essentials

Step 5: Fill in the WWWW:

What is the problem? nurses don't directly see the consequenses of sound pollution to the recovery of the patients
Who is involved? nurses and patients of the intensive care
When did it take place? whenever something happened causing can alarm or loud sound
Where did it take place? in the IC of the erasmus MC
Why did that happen? all sorts of causes can have an audible impact

A5. Meeting 1 : Nurse A

On the 11th of April, a little interview was performed with Nurse A about the sleep cycle and general silence of the ICU. When talking about the research, Nurse A could add a lot of necessary information.

One of the first things she said was that she would like to see voice recognition on medical devices. When an alarm rings (two minutes) after dismissing it, and you are working with both your hands, it would be grate to have speech recognition on the machines so that you can say 'dismiss alarm' and it stops ringing for 2 minutes again.

Alarms are being neglected far more often than you would expect nurses to. Sometimes it happens that alarms repeatedly ring for 4 to 6 minutes. With this in mind Nurse A would not be surprised if the Intensive Care would be one of the loudest environments in the hospital. However, there should be a bit of compassion. Having a little laugh with colleagues is necessary as it is impossible to otherwise remain positive being around these very ill people. A good means of saying this, is to keep the human factor alive within the nurses of the Intensive Care. You can not expect nurses to be silent for a complete shift of work.

In the intensive care, a fake biological rhythm is created in which it is 'prescribed' for patients when it is night, and when it is day. This rhythm is made to make sure that the sleep overnight is optimised by trying to keep the patients awake over day. This means that during awake-times, nurses make more noise than during night-time.

The night-time (sleep time) is around 22.00 and certainly not later than 23.00, the waking time is between 7.00 and 8.00. As read in Koens research, this is already measurable as the change of the shift kickstarts quite some noise production in nurses.

Alarms aren't completely bad, is what Erna wanted to add. The alarms also offer a great sense of security and confidence when nurses are still learning. You can not just remove all alarms from the Intensive Care, as some symptoms can not be seen by the naked eye. If you dismiss all alarms and you are working with your back to the patient, and the patient all of a sudden gets a cardiac arrhythmia, the patient could die without you noticing the symptoms.

Nurse A confirmed that it is true that nurses get less strict with setting their alarms over time. Younger nurses tend to set alarms really tight so that all small changes are made known immediately. Older nurses, or better said, more experienced nurses put them a lot less narrow and already know more when to act. My design should be adaptable to these different working styles. What she tries to teach the new nurses, is to stress that you first turn off the alarms before f.e. you start tapping off blood. This way you prevent that the alarm will ring when a small change is measured.

Sensors are also part of the 'alarm-equation'. some sensors are very sensitive to only the slightest movements. Blood-oxygen is for example measured through a clip on the fingers. Patients only have to make the slightest movement like rolling over in bed, or a simple cough, and the sensor is not attached properly anymore, leading to the alarm going off.

Even though the sounds of alarms cannot be changed by the nurses, the loudness can. All nurses have the habit of putting all alarms at the lowest, to be the least bothering to patients. Lastly she added that visitors of patients seldom are a problem. These are the quietest people around the whole Intensive Care. Visitors are, even though sometimes quite emotional, very calm and sit by the bedside holding the hand of the patient. They do not cause any harm or noise pollution.

A6. Meeting patient Riet

A short interview was performed with patient Riet, who has been a patient on the Intensive Care multiple times. Even though this was a scattered conversation, these were the main findings:

Patients want to be out of the ICU, and this can be obtained by improving their health. Improving your health is obviously not an activity that can be done manually, it happens to you when you are treated for properly and your body 'regenerates' itself. The main way to regenerate is through proper sleep. When asleep, the human body regenerates, and the deeper the patient sleeps, the better and deeper he restores.

Other factors that might have an impact are:

When hospitalised, you want to feel that the nurses are caring for you. You also want to have a bit the feeling of privacy, not too much alarms beeping, and a bit having the feeling that the place is your own and personal. The space shouldn't be completely closed, but comfort is definitely priority. Lastly it is nice to not have a completely isolated feeling, it's nice when every now and then a nurse or someone dear to you comes to visit you and doesn't leave you forgotten.

A7. Meeting 2 - Nurse B

When talking to Nurse B, a nurse with only a few years of experience on the 10th floor IC, a bit more insight in the workflow of nurses was gained. She told that normally younger nurses tend to set the limits for alarm really tight, because they still do not exactly know what will happen with the patients. They first need to get to know the 'health status' of the patient, and how they (and especially their body) react to the medication. That is why a lot of alarms occur when a lot of young and still learning nurses are on the IC.

Nurse B also told that she found a way of silencing the ICU a bit herself. As she told that she already started to gain more experience, she always shuts down all alarms when a patient just arrived. She stays at the bedside of the patient constantly so that she starts to know the patient, manually observing life sustaining values like blood pressure and heart rate. Then, when the patient is more stable already, she sets the upper and lower boundaries for the alarms.

This conversation shows that there already is some awareness of alarms, but later on the same nurse was found laughing and talking quite loud in the nurse post. As I together with my chair were standing in an empty ICU, trying to figure out the proper configuration of the Quietyme system, her interest got sparked. Us talking about the silent ICU might have lead to a socially favourable answer, something that further research and the data from Quietyme will show.

At the nurse post also something strange happened. The nurse post is the place where all nurses come to relax a little and have a break, while keeping overview of all patients using webcams. I kept my distance but observed what happened when alarms went off. Over a period of time the first alarms were acted upon quite quickly, by different nurses. After some time however, the other nurses remaining in the nurse post got into a conversation. When the other nurses returned to the post, they also got involved in this conversation. When another alarm went off, nobody looked at the screen and they only started to talk louder to keep understanding each other. This scenario was very reminiscent of the snowball effect that can also be witnessed when the volume of music is increased in a pub.

A8. Meeting 5 - Fly on the wall

Most of the stays on the Intensive Care are not short term. A regular length to stay is between two and five weeks. When a patient from the IC goes for an operation or scan, all machines remain attached. The 'broodje', the small censoring device is hooked up to another trolley, and together with all machines the patient is moved to their destination.

An interesting combination for a product would be to have a combination between movement and sound. When a patient is not moving too much, it could mean that he is alseep. In that case the maximum volume should be decreased to make sure the patient gets into the third stage of sleep. If the patient starts moving, the maximum volume may increase again.

The doors seem to isolate more than was expected. Normal conversations are almost inaudible behind a closed door.

From 8:00 to 10:30 there is a lot of noise on the rooms, but this is understandable as a lot of patients is taken care of. Afterwards there should probably be a moment of rest in which the nurses can go for a break and the patients can sleep.

When asking a nurse about the amount of alarms of during the afternoon, she said that it could not be prevented as the blood pressure decreases over time. "And then the alarm goes of and there is nothing that we can do about it." This means that an alarm system should be smart in a sense that it knows when a patient is asleep and thus, when to lower the boundaries a bit.

When a nurse puts her box on privacy mode, then the alarms are not transferred to the nurse box, unless they are absolutely critical (like a heart attack).

A9. Patient types

Each patient is different
An analysis of different patient archetypes.

A patient is moved to the intensive care when one of their vital functions is decreasing rapidly or functioning poorly. Vital signs are among others: breathing, cardiovascular functionalities, the nervous system and digestive tract. It could also be that a patient got a highly infectious disease or they have had a very intense surgery.

As all patients are different, so are their symptoms and cure times. Sometimes patients only stay for 2 or 3 days as they have to get a properly functioning home-ventilation system. And others have to remain multiple weeks after a brain surgery to make sure all vital functions remain functional with a high chance of delirium.

Overalll patients can be divided into three groups, patients that stay for a short, medium or long time. Different aspects of these three groups can be found in Table X, where can be seen that the longer a patient stays, the more they are influenced by sounds around them and the chances on getting PTSS or delirium increase.

Short stay 1-5 days

With a short stay patients are relatively healthy and are not very much affected by either alarms or other noise in the ICU. Even though they might have some nights where the patients do not sleep that well, they will recover fast as soon as they arrive back home. Chances of PTSS or Delirium are small.

Causes of intake could be:
A new attached home ventilator system.

Medium stay 1-2 weeks

With a medium stay, one should think about staying within an ICU for one or two weeks. Surgeries or illnesses that have preceded the intake of the patient are more severe than with the short stay patients. As patients lay longer on the IC, also the chance of either PTSS or a Delirium is increased as patients are most probably exposed to more alarms for a longer time.

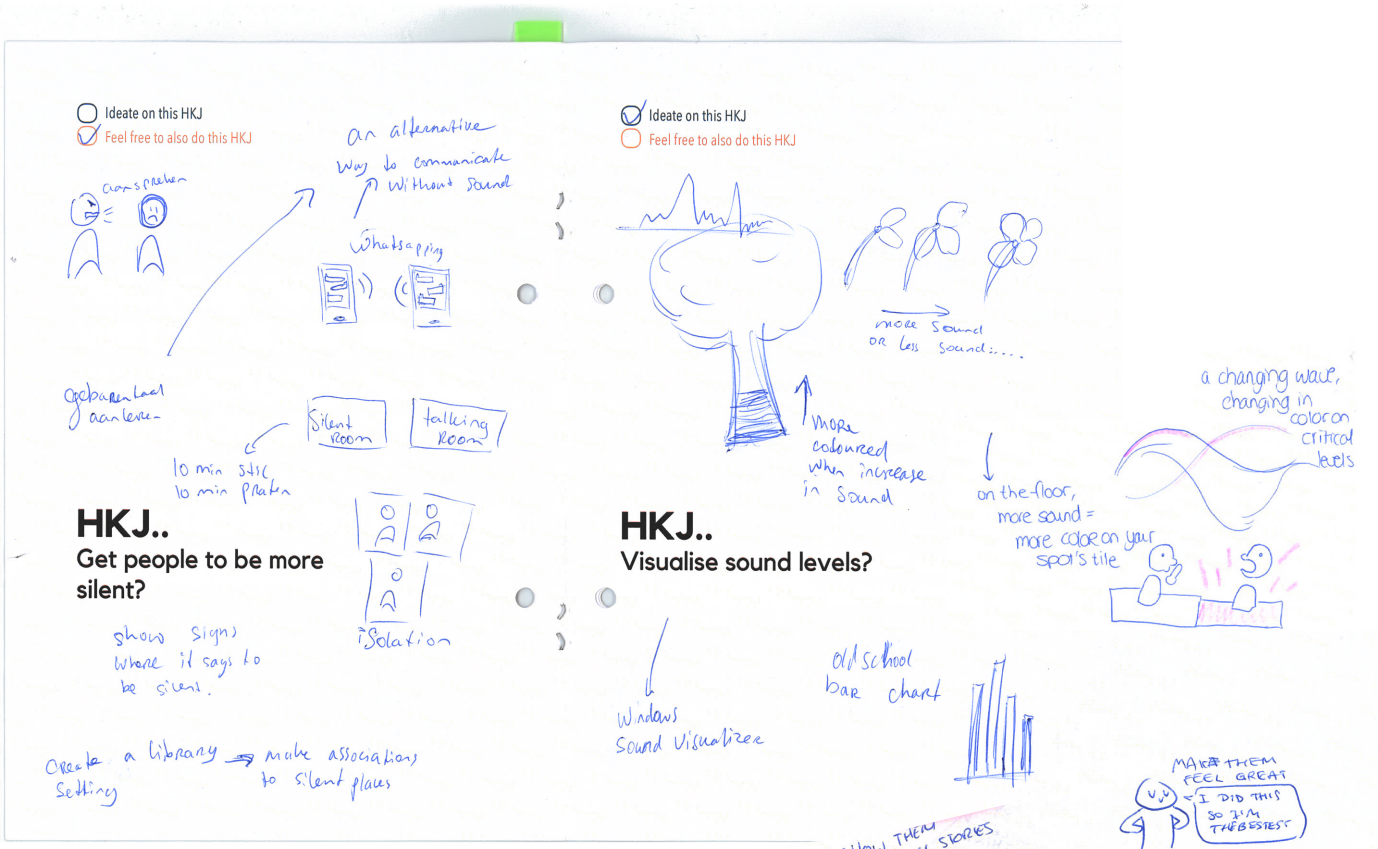
Causes of intake could be:
Temporary isolation after a infection of a organ
Check whether vital organs stay stable after a surgery for longer time

Long stay 3-9 weeks

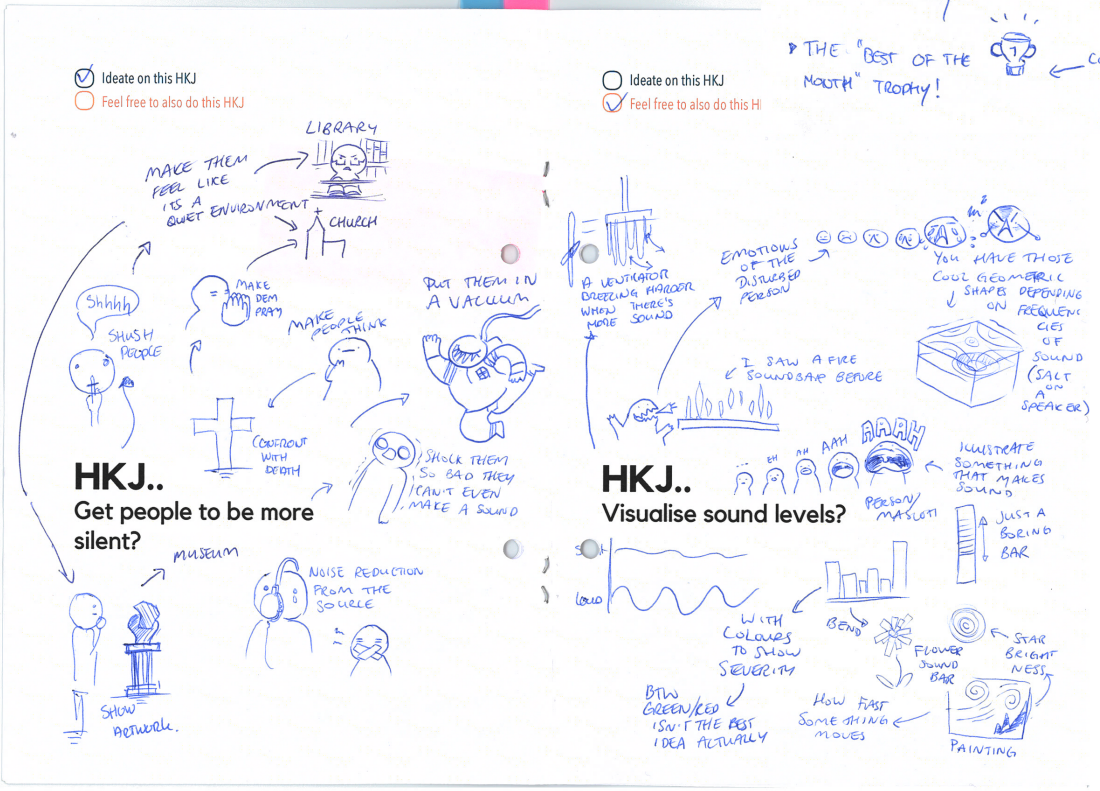
Long stay patients stay within the IC for 3 to 9 weeks. As can be expected, causes of their intake are very severe and their health status is on the brink between life and death. Patients are often sedated and are almost all immobilized. Chances of Delirium and PTSS are exceptionally high and their visit to the IC can in most cases be described as devastating. Patients in a longer stay are significantly older people (Martin, 2005).

Causes of intake could be:
Highly infectious diseases
Newly placed vital organs
Recovery from attempt of suicide

A10. How-to booklets

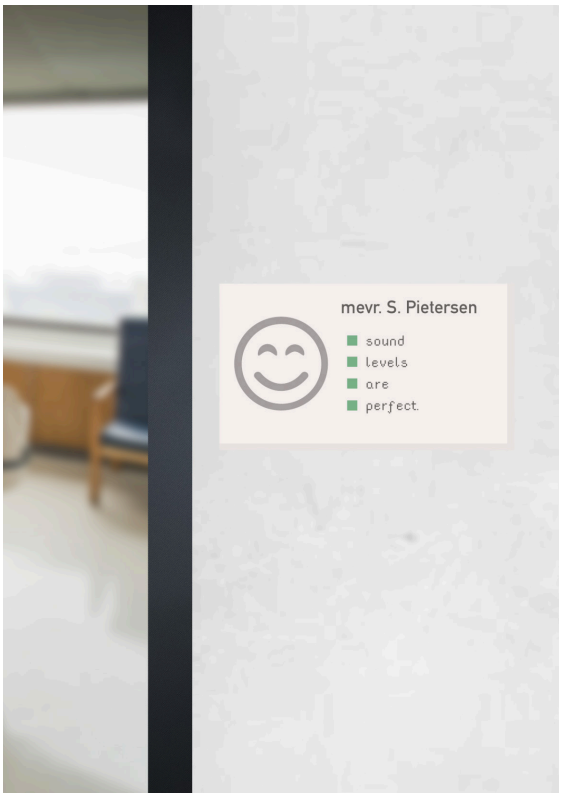

Ideate on this HKJ
Feel free to also do this HKJ
an alternative way to communicate without sound
whatsapping
conversation
gebaren taal aanleren
10 min stil
10 min praten
Silent Room
talking Room
HKJ..
Get people to be more silent?
show signs where it says to be silent.
iSolation
Ideate on this HKJ
Feel free to also do this HKJ
more sound or less sound....
more coloured when increase in Sound
HKJ..
Visualise sound levels?
Windows Sound Visualizer
on the floor, more sound = more color on your spot's tile
a changing wave, changing in color on critical levels
old school bar chart

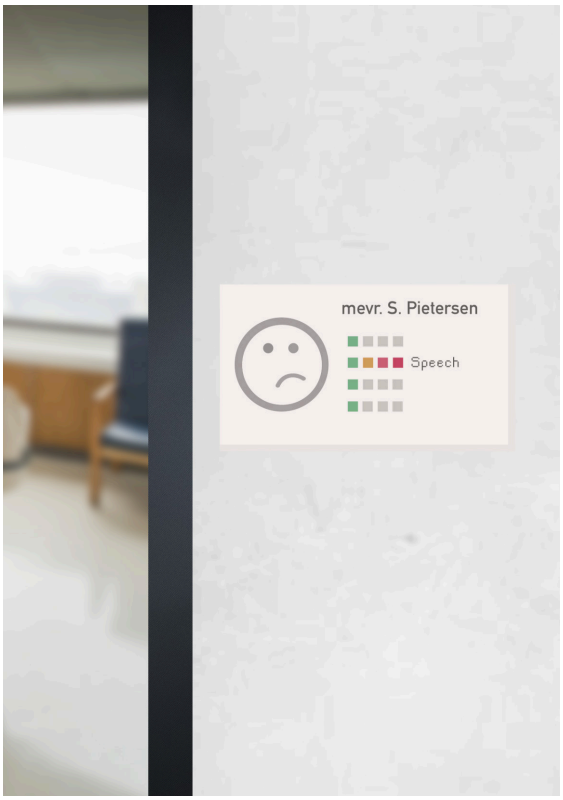

Create a library setting
make associations to silent places
MAKE THEM FEEL GREAT
I DID THIS SO I'M THE BESTEST
SHOW THEM SUCCESSFULL STORIES OF OTHERS
OMG A COOKIE
REWARDS/ PROFIT
DO IT OR U DIE
THREATEN THEM
HKJ..
Convince others to change their behaviour?
MAKE A PROPER REGULATION. YOU SHALL OBEY
MAKE IT A HABIT
I DRINK COFFEE EVERY DAY EVERY HOUR EVERY MINUTE
THE "BEST OF THE MOUTH" TROPHY!
COMPETITION


Ideate on this HKJ
Feel free to also do this HKJ
LIBRARY
MAKE THEM FEEL LIKE ITS A QUIET ENVIRONMENT
CHURCH
Shhhh
SHUSH PEOPLE
MAKE DEM PRAY
MAKE PEOPLE THINK
CONFRONT WITH DEATH
PUT THEM IN A VACUUM
SHOCK THEM SO BAD THEY CAN'T EVEN MAKE A SOUND
HKJ..
Get people to be more silent?
MUSEUM
NOISE REDUCTION FROM THE SOURCE
SHOW ARTWORK.
Ideate on this HKJ
Feel free to also do this HKJ
A VENTILATOR BREEZING HARDER WHEN MORE
EMOTIONS OF THE DISTURBED PERSON
I SAW A FIRE EXTINGUISHER BEFORE
You HAVE THOSE COOL GEOMETRIC SHAPES DEPENDING ON FREQUENCIES OF SOUND (SALT ON A SPEAKER)
HKJ..
Visualise sound levels?
ILLUSTRATE SOMETHING THAT MAKES SOUND
PERSON/ MASCOTT
JUST A BORING BAR
WITH COLORS TO SHOW SEVERITY
BEND
FLOWER SOUND BAR
STAR BRIGHT NESS
BTW GREEN/RED ISN'T THE BEST IDEA ACTUALLY
HOW FAST SOMETHING MOVES
PAINTING

A11. Morphological chart ideas

Patient cards





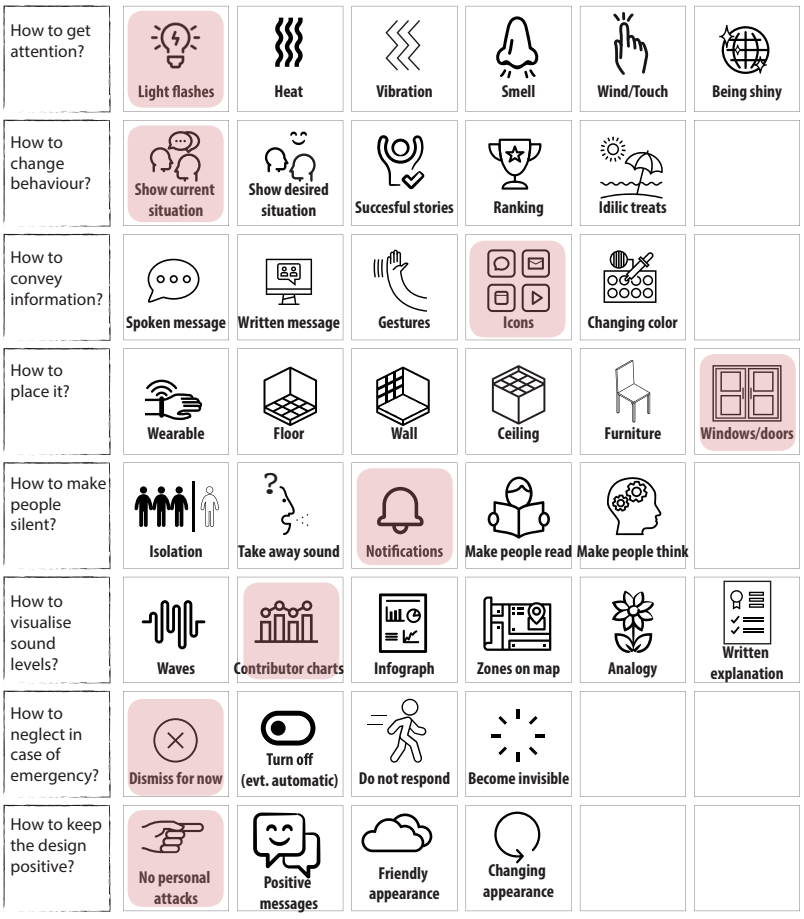
The patient card. The patient card is a digital way of showing not only easily accessible health information about the patient. It can also show data similar as found on the Quietyme web-tool.

1. Upon approach the patient card seems like a regular paper. Using E-ink the name of the patient is displayed. The LED smiley next to the name shows whether the patient is doing well or not. If for example the sound quality or the patient's health values are not good, this can be shown visually as a less happy smiley.
2. When sound levels are too high this can be elaborated upon on the side. Three or four icons show the different sources of the sounds and also show in a bar-chart style which were the main contribuants.
3. When a patient's health status is alarming, this can already be displayed (only the useful information for that moment) on the same part where normally sound information would be.

Remarks:

Research has shown that nurses are overloaded with information already, therefore only necessary health information would be shown if something happened.

A downside to this design would be that it is only visible outside of the ICU, as patient cards are always on the outside of the room. When formulated back to an opportunity this would make the implication that either the design would be visible on two sides, or that there is another communicative factor within the ICU, or there is no need to also have the information on the inside of the ICU.



Interactive painting

The interactive and informative painting. This idea is all about art, as art (and for me especially paintings) has something mesmerizing and silencing in it. As soon as I stand for before a painting, my eyes start exploring the emotion hidden within the canvas. This design has something similar within it, except instead of paint being used, all is displayed on a natural matte screen. The usage can be seen as a sequence of steps.

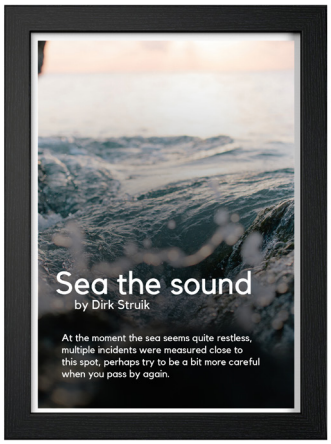
1. The painting measures whether the sound quality is suitable for the time of the day.
2. The painting converts its calculations in a scenery (in this example a small movie of the sea).
   A. If sound quality is good, the sea is nice and tranquil. A beautiful scenery to watch and enjoy.
   B. If the sound quality is too loud for the current situation, then the sea becomes more hostile. Perhaps with some thunder as well. Still a beautiful scenery to watch, but when you get used to the system, you will know that something has to change.
3. Luckily, if the sound quality is not good, you do not have to guess what the cause of the disturbance is. The painting has a proximity sensor built in, and thus knows when a person approaches. If the person is approaching the screen, the screen will have a fade in of the title of the 'artwork'. A small text stating what the cause of the disturbance is will also show up in a friendly way.
4. Afterwards, and continuously, the painting keeps measuring the sound levels, and relating them back to the time of the day to see whether the surrounding sound quality is adequate.

Remarks:
It is important to notice that there are a few remarks with this design. As already specified in the Morphological Chart it is necessary for nurses to have a way to neglect the device when very critical and unstable patients are just rolled into the Intensive Care. In such a case, the artwork would either turn off, show some news facts of the hospital, or take over the colors of the surroundings.

Second, the boundaries between a 'good hostile' image and a 'bad hostile' image are a bit of a grey area. For example, it is a nice view to have the example with the calm and hostile sea. However, have a bundle of flowers that is slowly browning and decaying, is something that you do not want to portray in a hospital in general. Therefore all used images should be thought of and designed with care.

Lastly, in this design the obvious design of the Quietyme sensors would be integrated. As mentioned in the behavior research, designs that are clearly measuring nurse behavior are being experienced as infringing and unpleasant. By taking away the obvious and putting it behind the scenes in this design, this might make nurses feel more comfortable again.

How to get attention?	Light flashes	Heat	Vibration	Smell	Wind/Touch	Being shiny
How to change behaviour?	Show current situation	Show desired situation	Succesful stories	Ranking	Idilic treats	
How to convey information?	Spoken message	Written message	Gestures	Icons	Changing color	
How to place it?	Wearable	Floor	Wall	Ceiling	Furniture	Windows/doors
How to make people silent?	Isolation	Take away sound	Notifications	Make people read	Make people think	
How to visualise sound levels?	Waves	Contributor charts	Infograph	Zones on map	Analogy	Written explanation
How to neglect in case of emergency?	Dismiss for now	Turn off (evt. automatic)	Do not respond	Become invisible		
How to keep the design positive?	No personal attacks	Positive messages	Friendly appearance	Changing appearance		

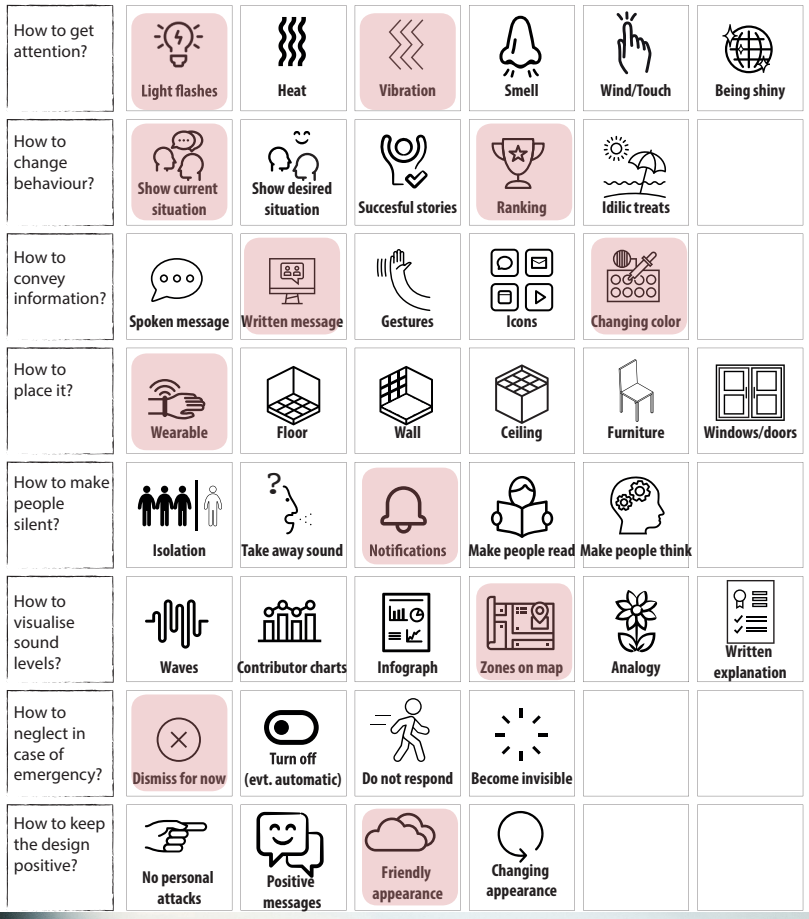


Patient cards

Color changing bracelets. Another possibility would be to give all nurses their personal bracelet that acts like a smart watch. Dependent on the nurses and bracelets location, the location will display what the local sound quality is like. Green is good, red is bad. When sound quality is low, an unhappy smiley says: 'whoops'. And a keyword like 'alarms', 'speech' or 'interaction' is displayed.

1. A nurse walks around the IC, the bracelet receives information dependent on the location where the nurse is. Quietyme sensors are still used to measure all the data, it is being placed in a location and transmitted to nurses wearing a bracelet near the same location
2. When a patient is in a critical and/or very unstable state. The bracelet will display nothing unless the nurse still wants to see the current state.
3. If a notification about poor sound quality has been missed multiple times, the bracelet can also vibrate, attracting the attention of the nurse to the bracelet.

Remarks
Only nurses will get information about the current audio quality, visitors do not have a bracelet and will therefore not know if they should visit or what the current state of the auditory environment is like.



Local sound block

Sound blocking is a technique that is seen more and more across devices like headphones and other sound related devices. The principle is quite simple. Sound consists of all sorts of waves that continuously shift over frequency and amplitude. When these waves are measured, and in near real-time the same waves are played backwards, the waves cancel each other out. This means a local near silence experience.

Remarks
This device would not whatsoever display what the main contribuants of the sound pollution are, and by taking all sounds away nurses might become even more 'deaf' to the alarms as they hear them less.
Also, most of the types of sound blocking that were so far found, were all in an enclosed space (e. g. an headphone shell). It is not sure yet whether a sound blocking device would work in a space as big as a room.

How to get attention?	Light flashes	Heat	Vibration	Smell	Wind/Touch	Being shiny
How to change behaviour?	Show current situation	Show desired situation	Succesful stories	Ranking	Idilic treats	
How to convey information?	Spoken message	Written message	Gestures	Icons	Changing color	
How to place it?	Wearable	Floor	Wall	Ceiling	Furniture	Windows/doors
How to make people silent?	Isolation	Take away sound	Notifications	Make people read	Make people think	
How to visualise sound levels?	Waves	Contributor charts	Infograph	Zones on map	Analogy	Written explanation
How to neglect in case of emergency?	Dismiss for now	Turn off (evt. automatic)	Do not respond	Become invisible		
How to keep the design positive?	No personal attacks	Positive messages	Friendly appearance	Changing appearance		

Interactive floor

Informative floor. An accessible way of bringing over information would be via either the floor or the walls. For this idea was chosen to pursue with the floor. Remember how a disco-floor is always drawn? Full with tiles that light up in all funky colors. This is something similar, but then toned down and more informative. Screens are placed all over the floor and show circles in areas where there have been multiple disturbances already. Around the circle can also be found what the source of the sound disturbance is.

People walk over the informative floor and hear sounds around them
People see where a lot of sounds have been lately and try to avoid these spaces.

Remarks
This idea might be unsuitable as the IC in the Erasmus has already been built and this would be quite an elaborate update/change in appearance.

People are unintentionally lazy. For example, when they walk through a forest over a path, and they see a quicker way to get to the same point, they will take that faster way. When people would now see a big circle on the floor notifying that sound is poor, people would probably still go the fastest way, just directly next to the circle. This would make the design less strong in making a statement.

How to get attention?	Light flashes	Heat	Vibration	Smell	Wind/Touch	Being shiny
How to change behaviour?	Show current situation	Show desired situation	Succesful stories	Ranking	Idilic treats	
How to convey information?	Spoken message	Written message	Gestures	Icons	Changing color	
How to place it?	Wearable	Floor	Wall	Ceiling	Furniture	Windows/doors
How to make people silent?	Isolation	Take away sound	Notifications	Make people read	Make people think	
How to visualise sound levels?	Waves	Contributor charts	Infograph	Zones on map	Analogy	Written explanation
How to neglect in case of emergency?	Dismiss for now	Turn off (evt. automatic)	Do not respond	Become invisible		
How to keep the design positive?	No personal attacks	Positive messages	Friendly appearance	Changing appearance		

LED wall panels

Padded wall panels. The hospital has a clinical appearance, and due to ease of cleaning there are little to none fluffy materials to be found within hospital environments. However, that does not mean that there are no materials suitable for hospital use (cleanable with alcohol to remove bacteria. A low density Polyurethane is, when lined properly, perfectly suitable for hospital use as well.

1. The padded wall panels act like long tubes being filled with sound. The fuller the tube, the louder the environment.
2. The 'fillings' of the tube consist of all sorts audio, but there is a way to distinguish which sort of sound polluted most. There will be three different colors making up the complete content. The more hostile the sound-sort is, the heavier it flows.
3. The (LED) lights within the device are dimmable, and when nobody is near, the light intensity is very low so that it does not bother patients who are trying to sleep.

How to get attention?	Light flashes	Heat	Vibration	Smell	Wind/Touch	Being shiny
How to change behaviour?	Show current situation	Show desired situation	Succesful stories	Ranking	Idilic treats	
How to convey information?	Spoken message	Written message	Gestures	Icons	Changing color	
How to place it?	Wearable	Floor	Wall	Ceiling	Furniture	Windows/doors
How to make people silent?	Isolation	Take away sound	Notifications	Make people read	Make people think	
How to visualise sound levels?	Waves	Contributor charts	Infograph	Zones on map	Analogy	Written explanation
How to neglect in case of emergency?	Dismiss for now	Turn off (evt. automatic)	Do not respond	Become invisible		
How to keep the design positive?	No personal attacks	Positive messages	Friendly appearance	Changing appearance		

A12. Research 2: math test

Calculations.

Solve them within the given time.
If you finish early, tell the researcher, he will continue the test for you.

1. 16 + 18 =
2. 3 x 17 =
3. 89 - 44 =
4. 15 x 17 =
5. 290 - 85 =
6. 4 x 82 =
7. 144 : 9 =
8. 993 : 6
9. 456 - 214 =
10. 22 x 11 =

11. 763 - 590 =
12. 72 : 6 =
13. 14 x 3 =
14. 189 - 76 =
15. 217 - 136 =
16. 76 x 9 =
17. 8 x 33 =
18. 7 x 8 =
19. 8 x 12 =
20. 17 + 44 =

21. 63 : 7 =
22. 24 x 8 =
23. 20 + 88 =
24. 56 : 7 =
25. 150 : 5 =
26. 405 - 63 =
27. 109 + 108 =
28. 42 x 12 =
29. 99 - 54 =
30. 377 + 198 =

31. 766 + 219 =
32. 50 - 93 =
33. 96 x 67 =
34. 985 - 219 =
35. 14 x 25 =
36. 908 +98 =
37. 48 : 3
38. 12 x 16 =
39. 76 - 48 =
40. 126 : 6 =

Good luck !

A13. Research 2: research forms and results

Researcher form

Name _____ Age _____

Gender _____

Occupation _____

Test number

Performed test

☐ Sequence of lights ☐ Change of color

☐ Sequence of vibrations ☐ Written message

Test responses

	Response time	Correct answer?	
1		Y	N
2		Y	N
3		Y	N
4		Y	N
5		Y	N

Which one would be perceived easiest?

☐ Sequence of lights ☐ Change of color

☐ Sequence of vibrations ☐ Written message

and why?

Which one would be perceived comfortable?

☐ Sequence of lights ☐ Change of color

☐ Sequence of vibrations ☐ Written message

and why?

Likert scale questions

I enjoy this way of being notified

I understood what was communicated to me

The way how was communicated to me was effective

I had difficulty understanding what the design ws trying to say to me.

The experience was not enjoyable

1 = totally disagree, 7 = totally agree

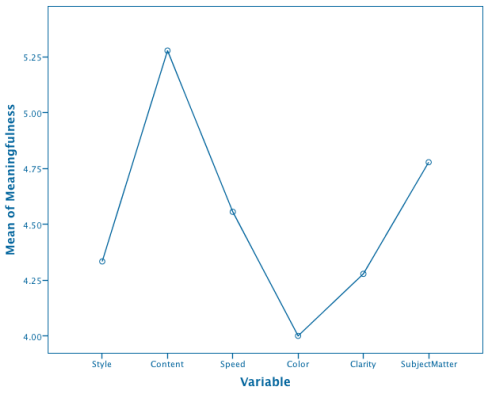
How would the participant see his method working in an ICU?

Did the participant feel more stressed?

☐ Yes

☐ No

Other remarks



Meaningfulness

Tukey HSD[a,b]

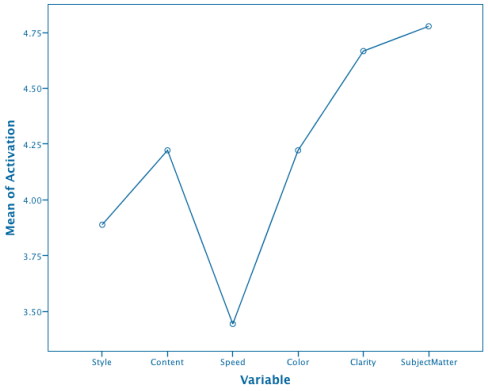
Variable	N	Subset for alpha = 0.05
		1
Color	17	4.0000
Clarity	18	4.2778
Style	18	4.3333
Speed	9	4.5556
SubjectMatter	9	4.7778
Content	18	5.2778
Sig.		.394

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 13.401.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Means of meaningfulness per variable.



Activation

Tukey HSD[a,b]

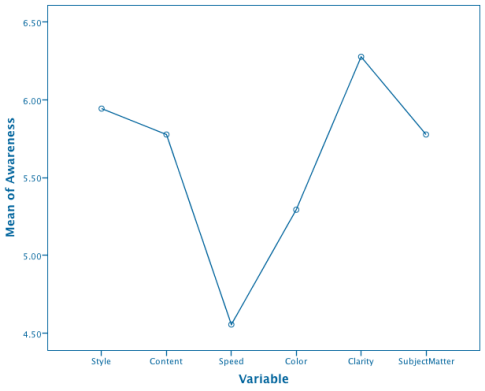
Variable	N	Subset for alpha = 0.05
		1
Speed	9	3.4444
Style	18	3.8889
Content	18	4.2222
Color	18	4.2222
Clarity	18	4.6667
SubjectMatter	9	4.7778
Sig.		.394

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 13.500.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Means of activation per variable.



Awareness

Tukey HSD[a,b]

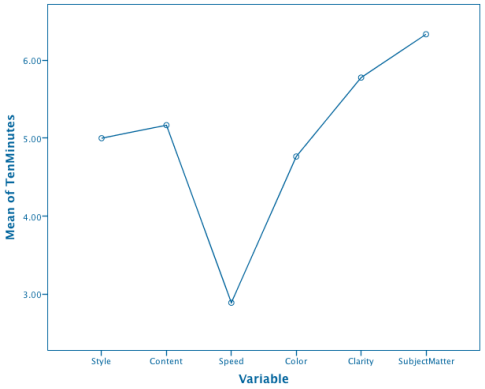
Variable	N	Subset for alpha = 0.05
		1
Speed	9	4.5556
Color	17	5.2941
Content	18	5.7778
SubjectMatter	9	5.7778
Style	18	5.9444
Clarity	18	6.2778
Sig.		.057

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 13.401.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Means of awareness per variable.



TenMinutes

Tukey HSD[a,b]

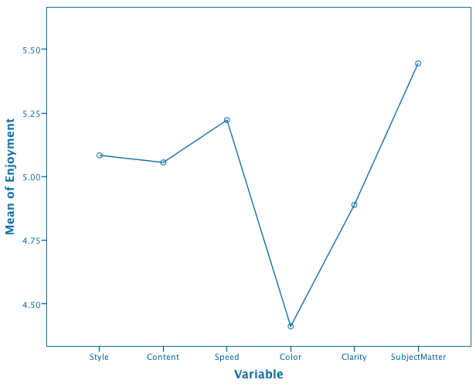
Variable	N	Subset for alpha = 0.05	
		1	2
Speed	9	2.8889	
Color	17	4.7647	4.7647
Style	18		5.0000
Content	18		5.1667
Clarity	18		5.7778
SubjectMatter	9		6.3333
Sig.		.067	.189

Means for groups in homogeneous subsets are

a. Uses Harmonic Mean Sample Size = 13.40

b. The group sizes are unequal. The harmonic group sizes is used. Type I error levels are not

Means of how likely participants thought they would see the difference with ten minutes in between, per variable.



Enjoyment

Tukey HSD[a,b]

Variable	N	Subset for alpha = 0.05
		1
Color	17	4.4118
Clarity	18	4.8889
Content	18	5.0556
Style	18	5.0833
Speed	9	5.2222
SubjectMatter	9	5.4444
Sig.		.445

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 13.401.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Means of enjoyment per variable.

A14. Research 3: respondent form

Land

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Paint

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Test A

Participant no. ☐

Name _____

Age ____ **Gender** _____

Occupation _____

Are you color blind? Yes / No

Thank you for participating in my test!

Please sign at the X to confirm that you are in this test voluntary and that you are aware that can stop at any given moment without consequences. You hereby give consent to make me use your results for the benefit of my graduation. All results will be made anonymous and will not be directly tracable to you as person. You will be rewarded with a snack after the test to show my gratitude for you investing time in my graduation.

date signature

__/__/___ **X** _____

Clouds

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Sea

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Fire

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Aerial

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Traffic

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Ducks

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Leaves

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Animals

	A	B
Which one was louder?		
Meaning-fulness		
Activation		
Awareness of change		
After 10 minutes?		
Enjoyment		

Notes

Meaningfulness
I quickly understood the relation between the video and the environment

Totally disagree 1 2 3 4 5 6 7 Totally agree

The link between the video and the environment was unclear

Totally disagree 1 2 3 4 5 6 7 Totally agree

Activation
This transition in videos made me want to act in the environment

Totally disagree 1 2 3 4 5 6 7 Totally agree

Awareness of change
I properly noticed a change between the two videos

Totally disagree 1 2 3 4 5 6 7 Totally agree

The change between states was unclear

Totally disagree 1 2 3 4 5 6 7 Totally agree

The change between states was clear

Totally disagree 1 2 3 4 5 6 7 Totally agree

Enjoyment
I enjoyed watching this videoset

Totally disagree 1 2 3 4 5 6 7 Totally agree

That's it! Thank you so much for helping out!

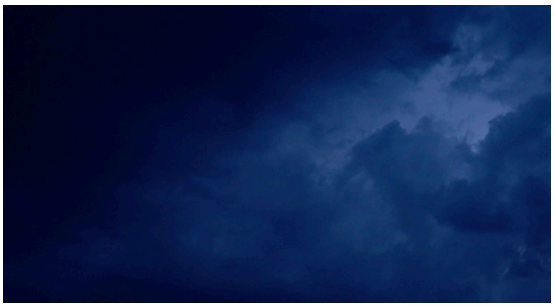
A15. Research 3: video snaps

	Test A
	Land Paint Clouds Sea Fire Aerial Traffic Ducks Leaves Animals

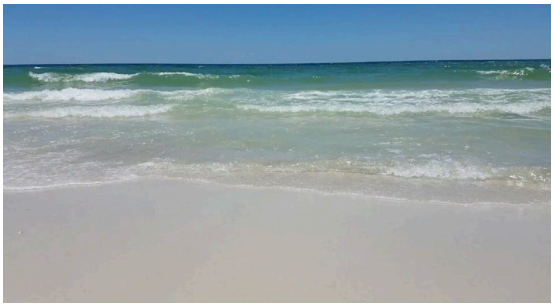
A1 Land


A2 Paint


A3 Clouds

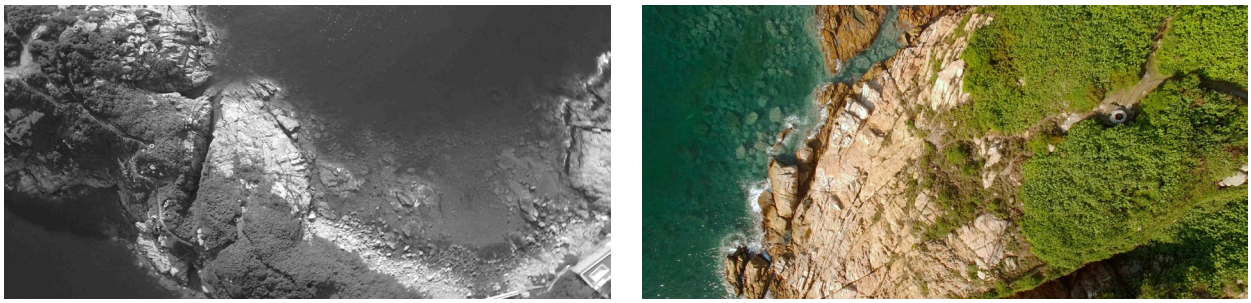



A4 Sea

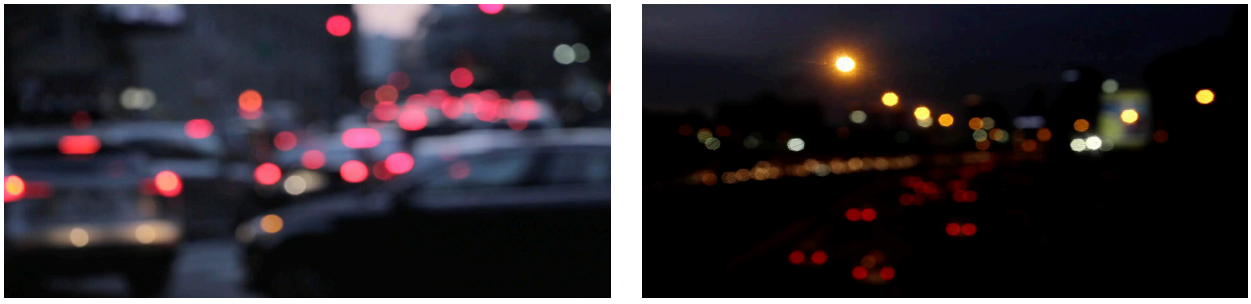



A5 Fire

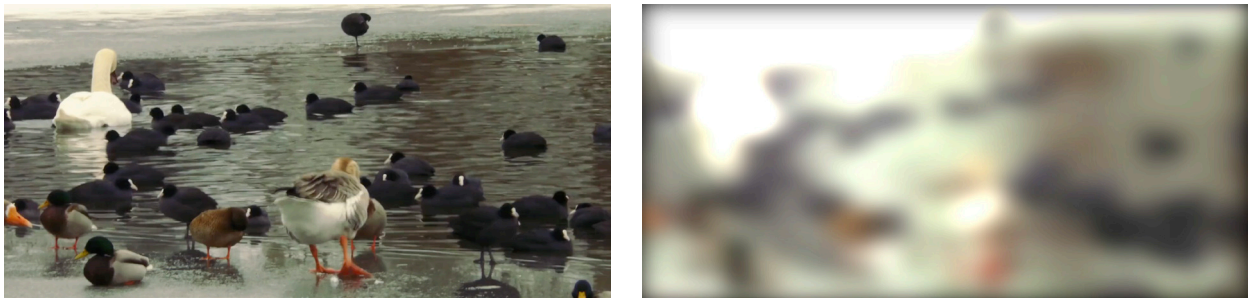

A6 Aerial



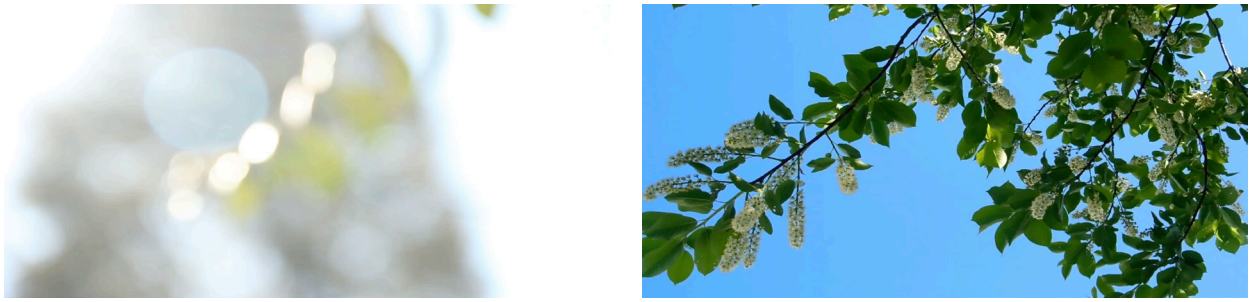
A7 Traffic



A8 Ducks



A9 Leaves



A10 Animals

Test B

Ripples
Sheep

Coffee
Traffic

Cherries

Bokeh
Leaves

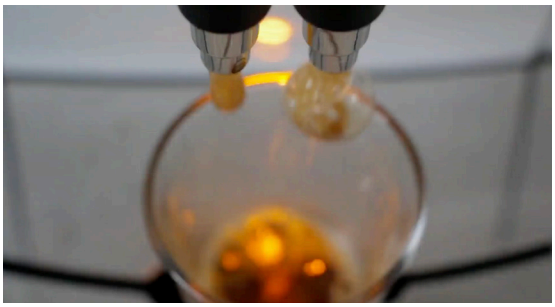
People
Sea

Kaleidoscope

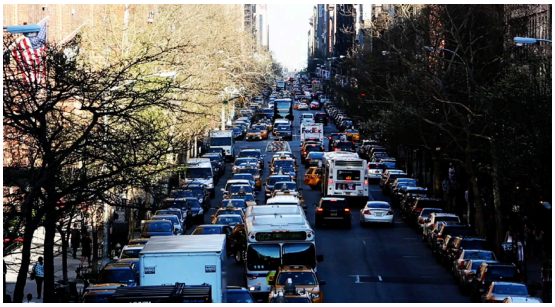
B1 Ripples


B2 Sheep


B3 Coffee



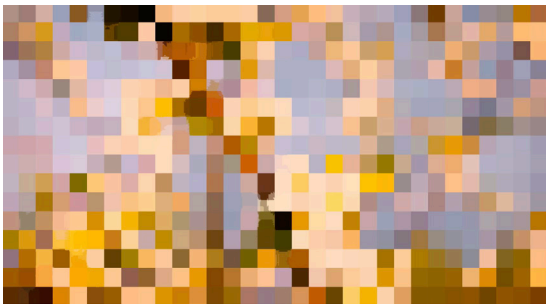

B4 Traffic

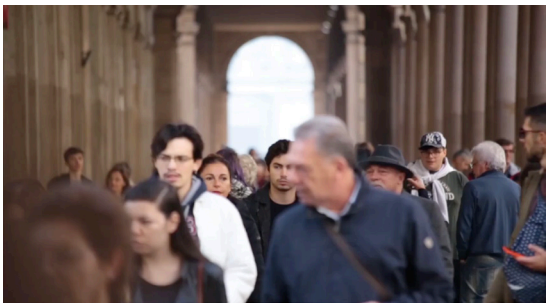
B5 Cherries


B6 Bokeh

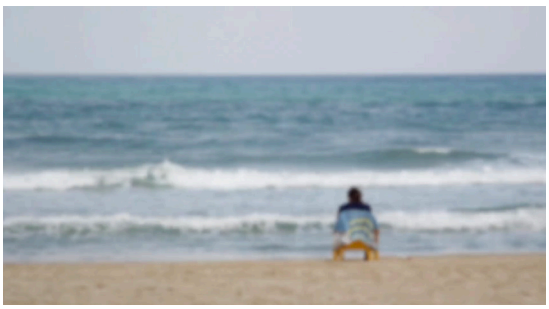
B7 8bit leaves



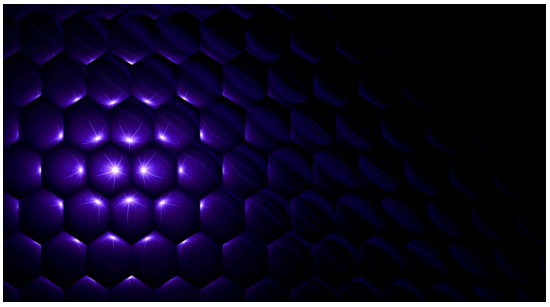
B8 People



B9 Sea

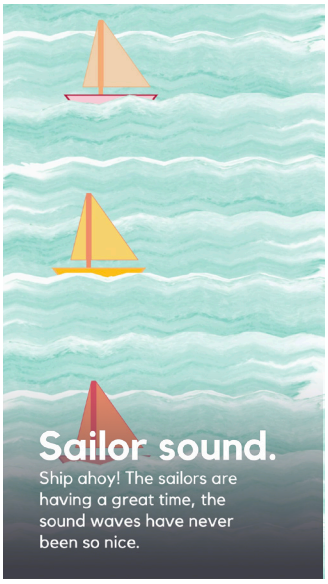


B10 kaleido

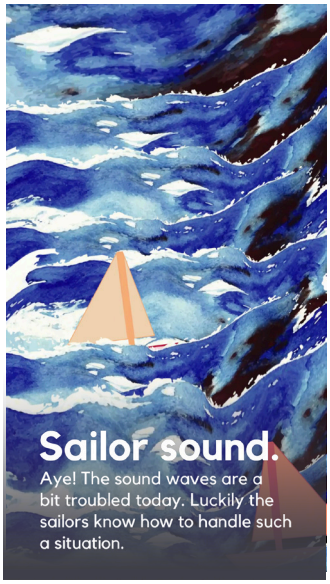


A16. Text over visuals

Quiet Okay

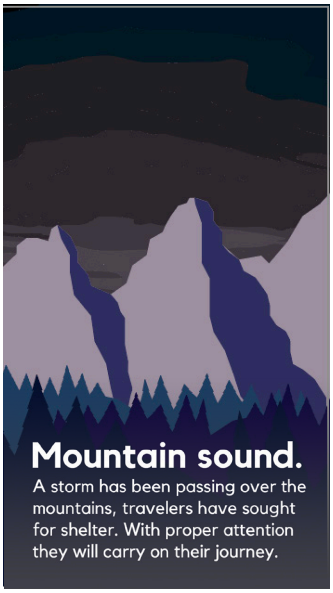


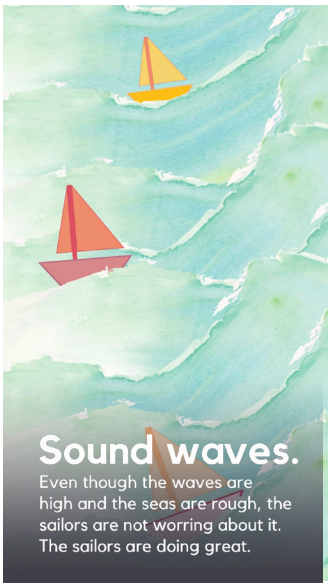
Quiet not okay



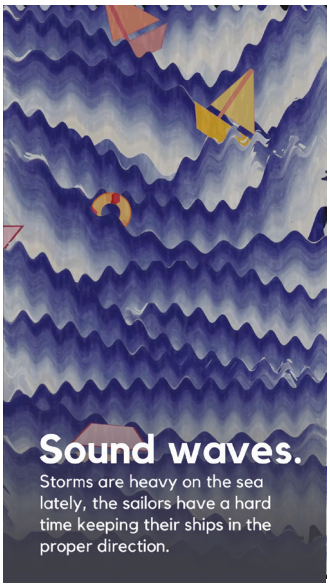
Quiet Okay

Quiet not okay

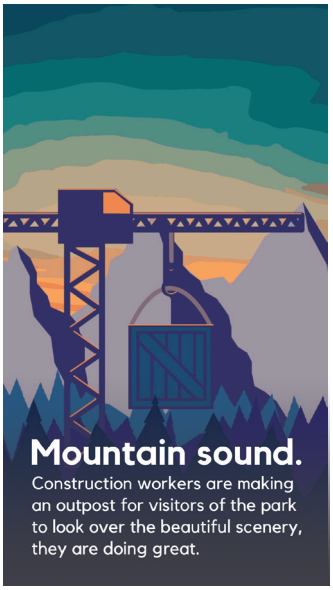




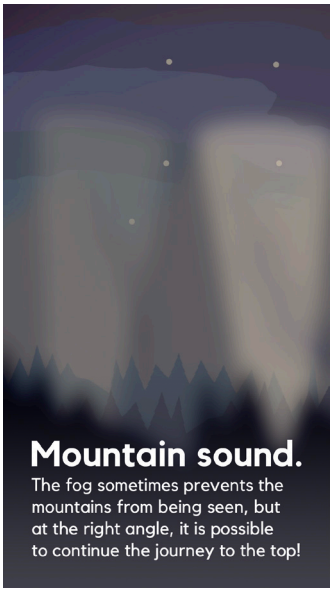
Loud okay



Loud not okay

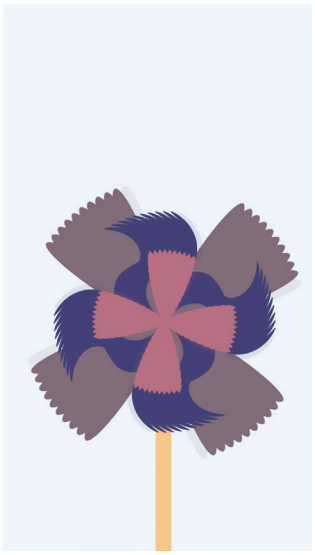


Loud okay

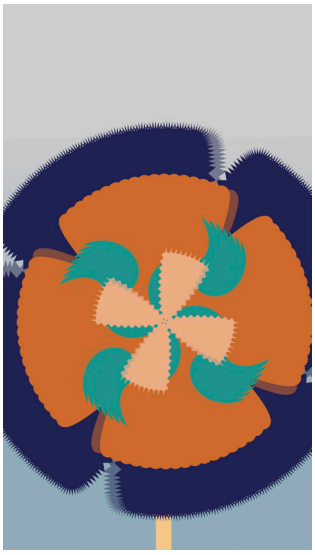


Loud not okay

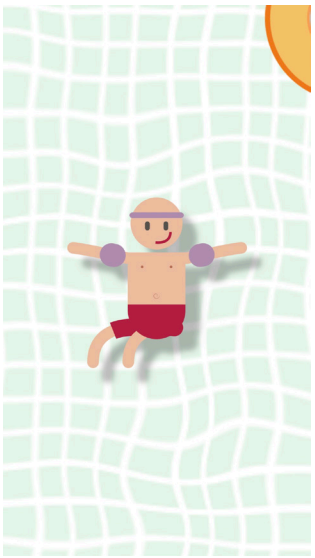
A17. More visualisations



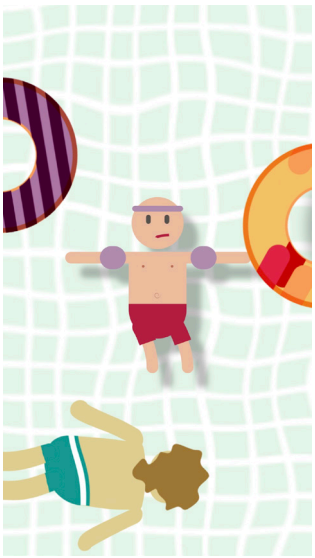
Quiet
Fan of sounds



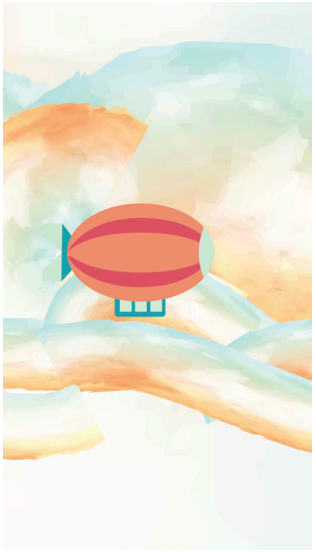
Loud



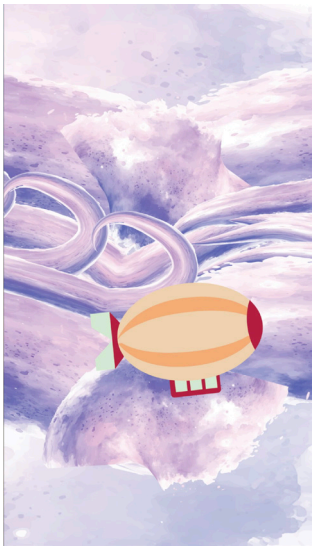
Quiet
Wave maker



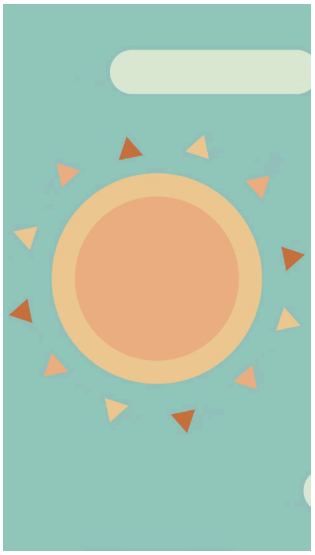
Loud



Quiet
Airy balloon



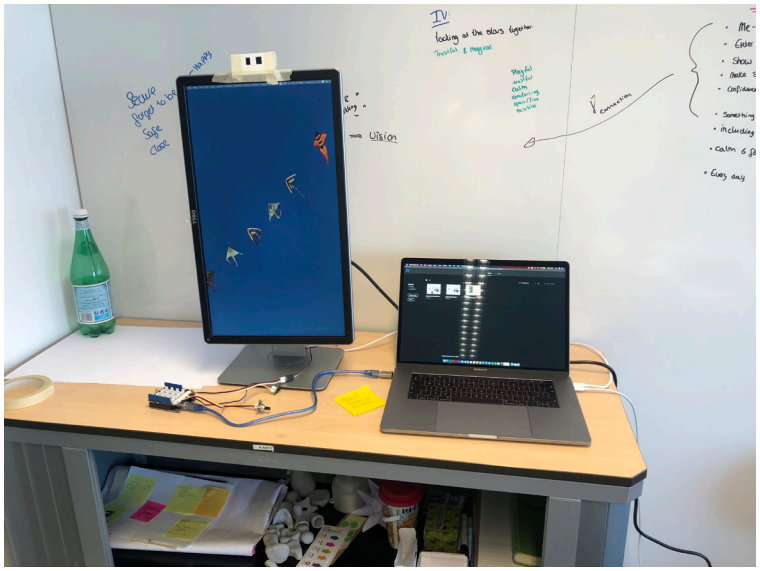
Loud



Quiet
Sunny sounds

Loud

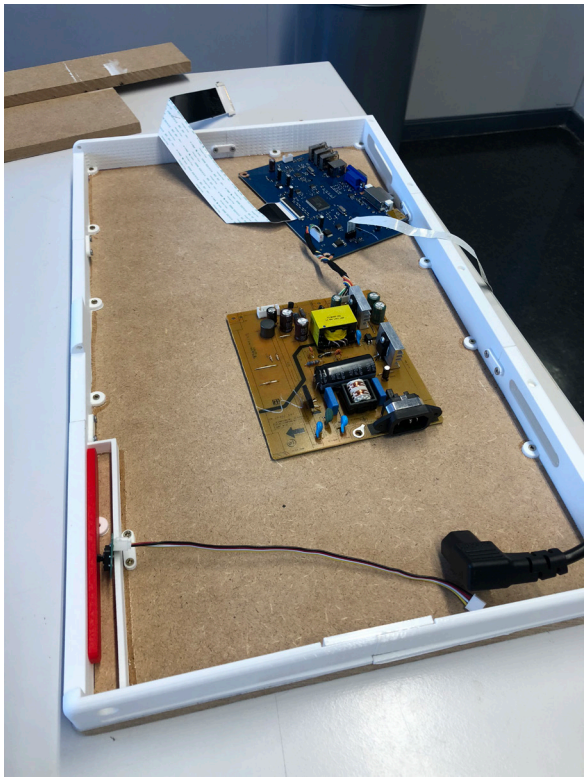
A18. Prototyping photos



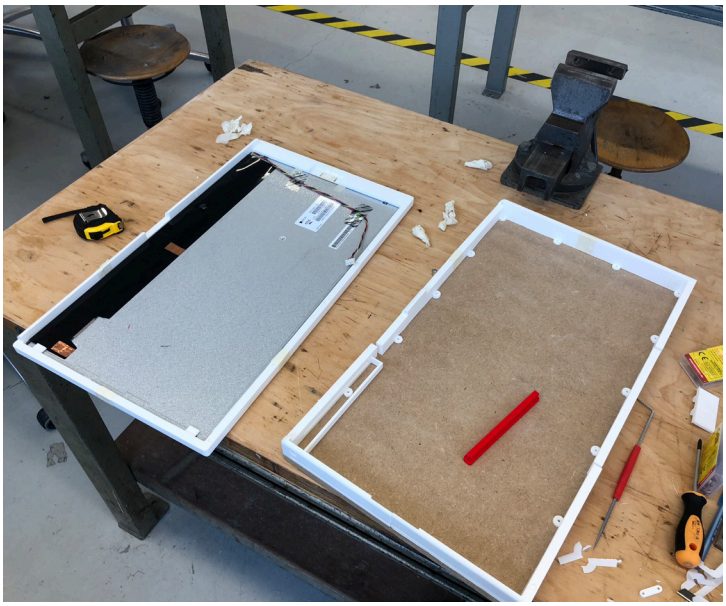
An MVP setup was tested before the full model was made.

The front panel and the encasing were first glued to create one piece of all parts..

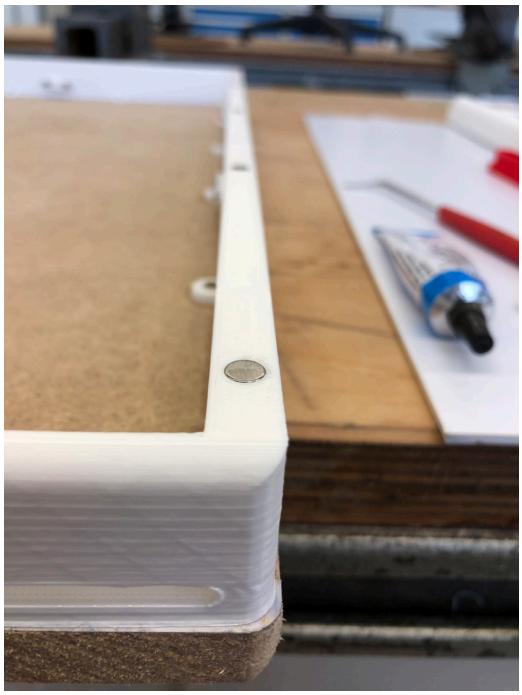
...and these were then also screwed together to be sure that Doplor would stay in one piece.



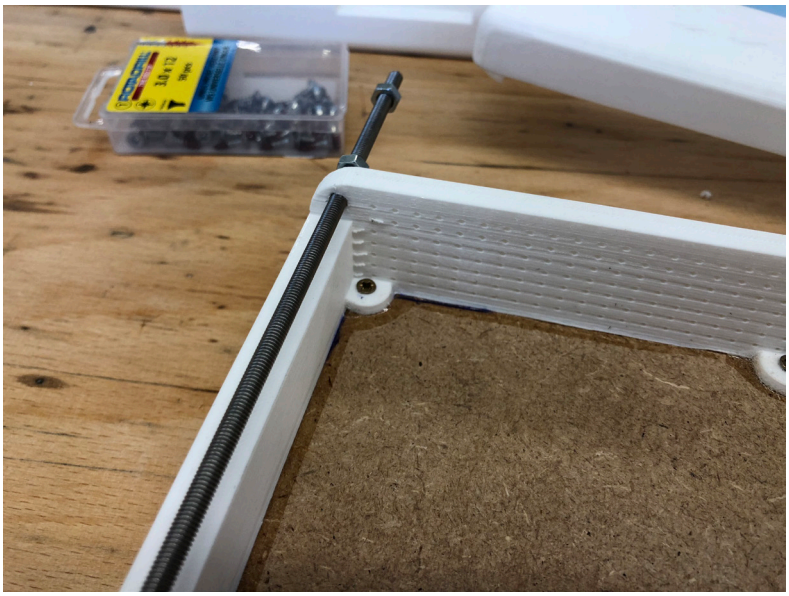
All necessary electronics were fitted and placed in an optimized location.



I rechecked wether the screen still had a proper fit, this luckily was the case. (The second time)

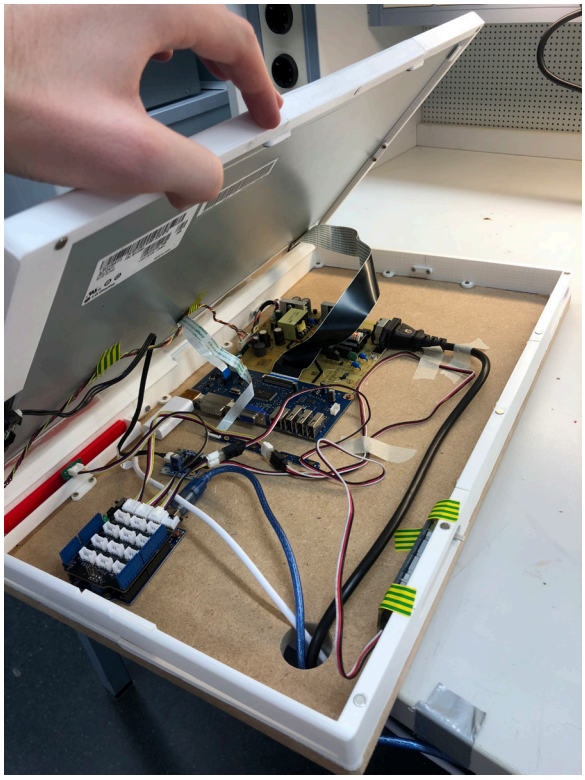


Magnets were glued into the encasing and the front panel so that the screen and back would not separate unwantedly.

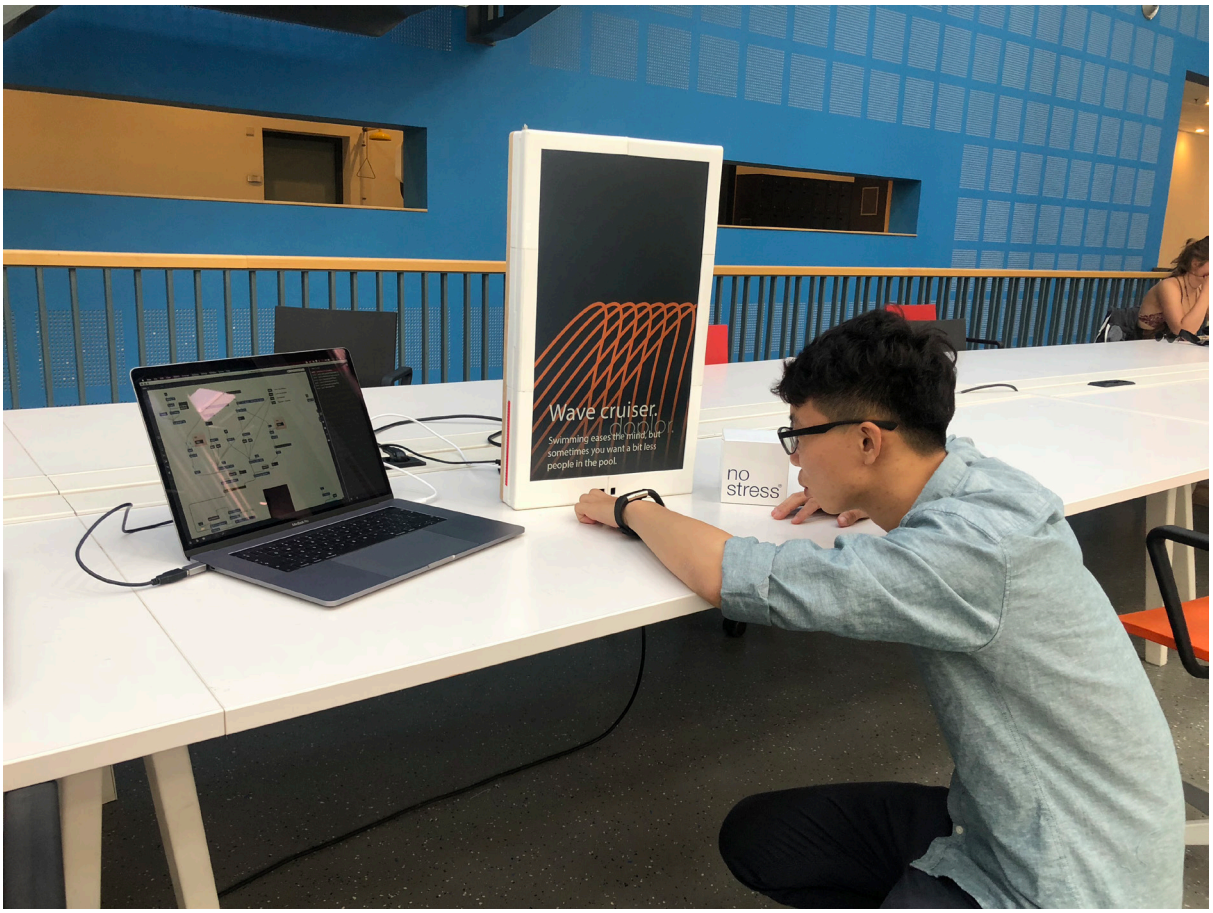


The screwthread was fitted to make sure that the hinge would not be too loose..

The holes were in fact so tight that it was impossible to assemble the hinge by hand. An electric drill was used to put the hinge in.

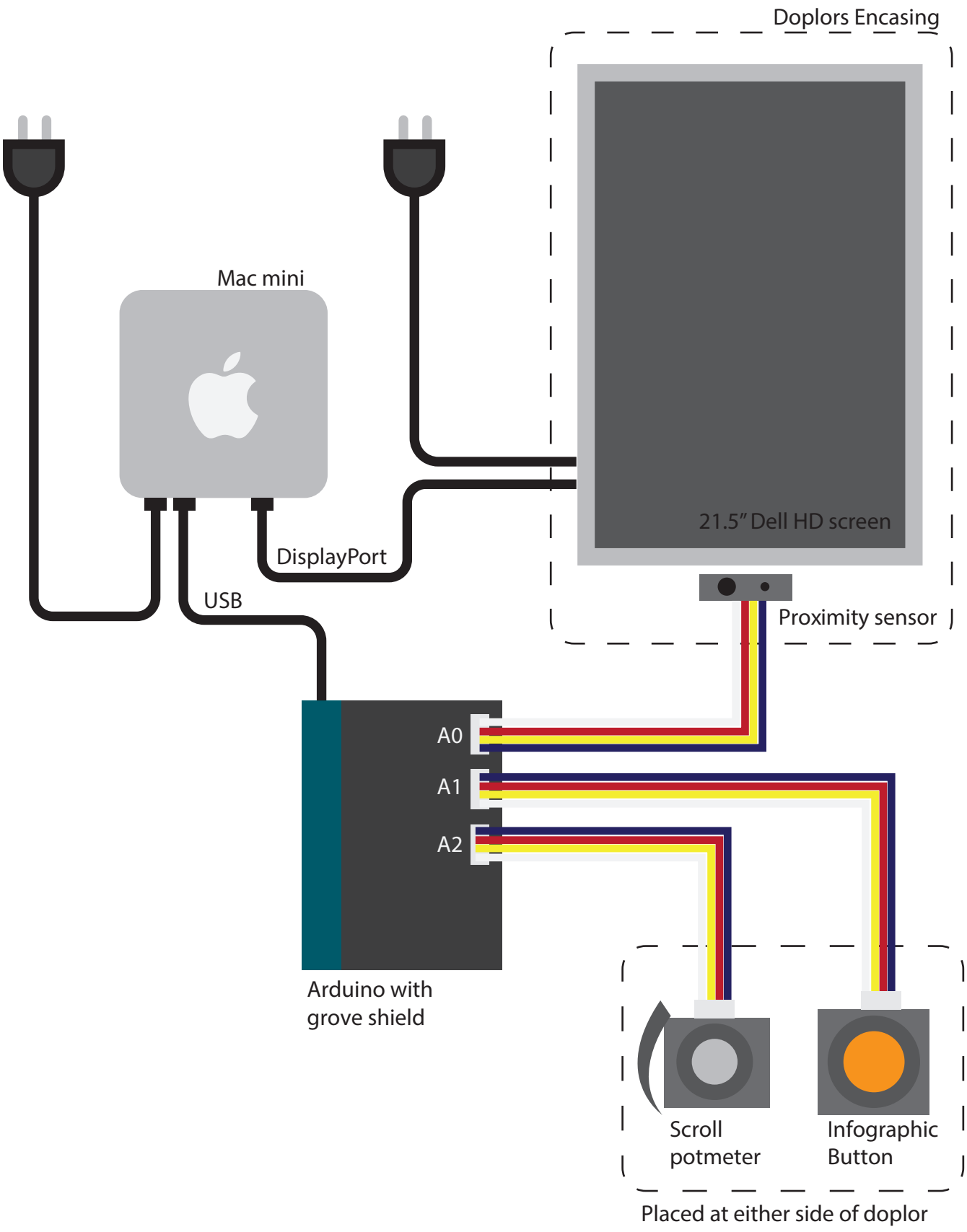


All electronics, including this time the arduino were placed, an all cables were attached.



All ready to be tested!

A19. Electrical flowchart



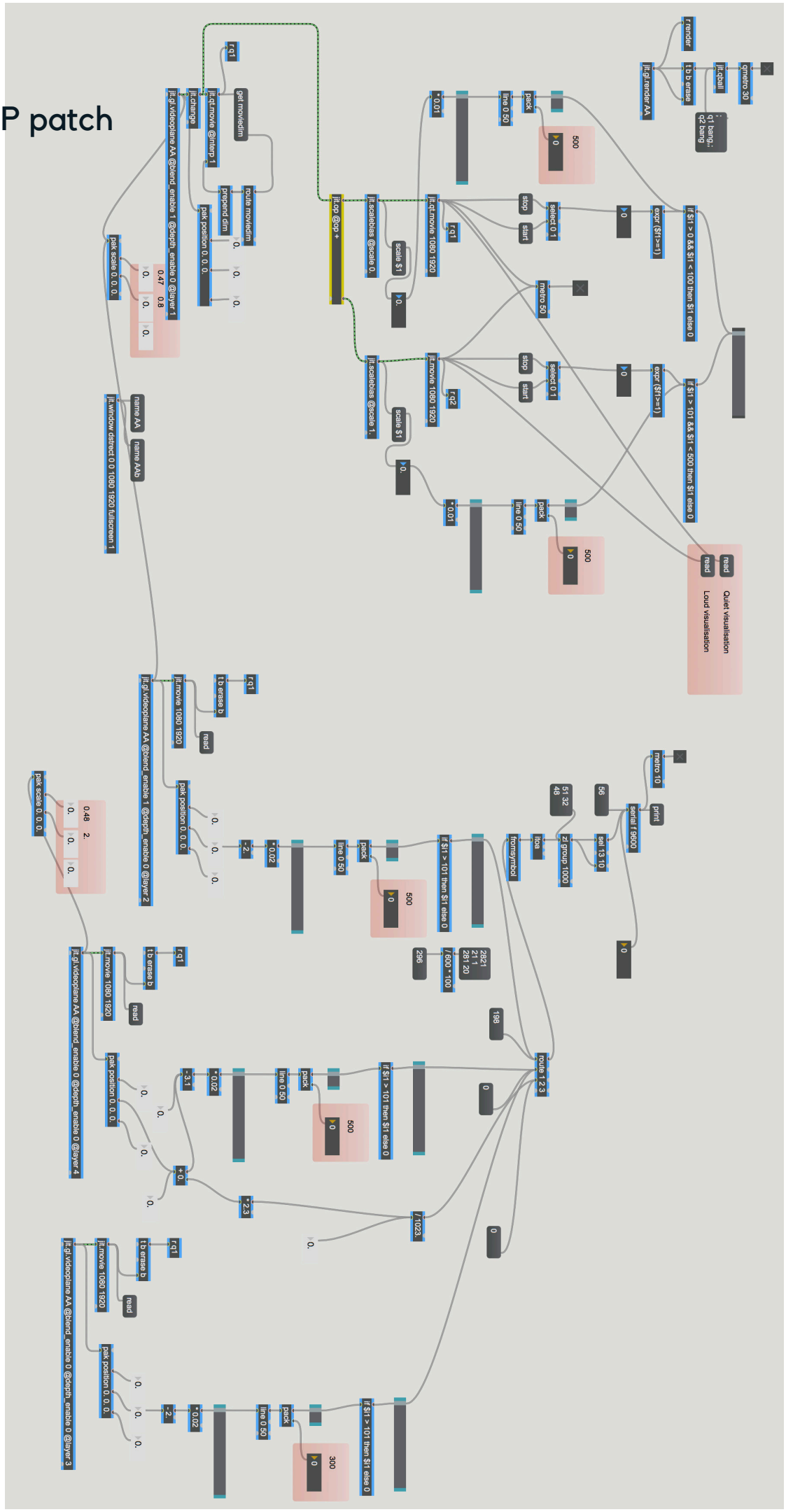
Arduino code

```
const int loudnessPin = A3;
const int infoButton = A1;
const int infoSlider = A2;
const int proxPin = A0;
const int choiceButton = 3;

int choiceReadings = 0;

int loudnessState = 0;
int infoButState = 0;
int infoSlideState = 0;
int proxState = 0;
int choiceButState = 0;

void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
pinMode(loudnessPin, INPUT);
pinMode(infoButton, INPUT);
pinMode(infoSlider, INPUT);
pinMode(proxPin, INPUT);
pinMode(choiceButton, INPUT);

}

void loop() {
  // put your main code here, to run repeatedly:

loudnessState = analogRead(loudnessPin);
Serial.print(loudnessState);
Serial.print('\t');

infoButState = analogRead(infoButton);
Serial.print(infoButState);
Serial.print('\t');

infoSlideState = analogRead(infoSlider);
Serial.print(infoSlideState);
Serial.print('\t');

proxState = analogRead(proxPin);
Serial.print(proxState);
Serial.print('\t');

choiceButState = digitalRead(choiceButton);
if (choiceButState == LOW ){

  if(choiceReadings <= 1){
  choiceReadings++;
  Serial.print(choiceReadings);
  }

  else {
  choiceReadings = 0;
  Serial.print(choiceReadings);
  }

  delay (500);

  }

   else {
   choiceReadings = 0;
   Serial.print(choiceReadings);
   }

   delay (500);

   }

 else if (choiceButState == HIGH){
   Serial.print(choiceReadings);
 }

 Serial.println();

 delay(500);
 }
```

Processing code

```
// START OF CODE //

import processing.serial.*;
import processing.video.*;

Movie displayedMovie;
Movie [] movieQuietOkay = new Movie[3];
Movie [] movieQuietNotOkay = new Movie [3];
Movie [] movieLoudOkay = new Movie [3];
Movie [] movieLoudNotOkay = new Movie [3];

PImage displayedTitle;
PImage [] titleQuietOkay = new PImage[3];
PImage [] titleQuietNotOkay = new PImage[3];
PImage [] titleLoudOkay = new PImage[3];
PImage [] titleLoudNotOkay = new PImage[3];

int DistVal;
String loudness = null;
int LoudVal;
int VisChoice;
int InfoButton;
int InfoSlider;

int nl = 10;

Serial mySerial;
String myString;
int count;

float moveY = -1920;
float transparency = 0;

int videostate = 0;


  void setup() {
  size(1080, 1920);
  frameRate(30);
  String myPort = Serial.list() [10];
  mySerial = new Serial(this, myPort, 9600);



    movieQuietOkay[0] = new Movie(this, "7QO.mp4");
    movieQuietNotOkay[0] = new Movie(this, "7QNO.mp4");
    movieLoudOkay[0] = new Movie(this, "7LO.mp4");
    movieLoudNotOkay[0] = new Movie(this, "7LNO.mp4");
    titleQuietOkay[0] = loadImage("7QO.png", "png");
    titleQuietNotOkay[0] = loadImage("7QNO.png");
    titleLoudOkay[0] = loadImage("7LO.png");
    titleLoudNotOkay[0] = loadImage("7LNO.png");


void readArduino() {


  while (mySerial.available() > 0) {
    //..   loudness = mySerial.readStringUntil(nl);
    String myString = mySerial.readStringUntil(nl);

    if (myString != null) {
      myString = trim(myString);
      int mysensors[] = int(split(myString, '\t'));
      count = mysensors.length;

      if(count == 5){
      LoudVal= mysensors [0];
      InfoButton = mysensors [1];
      InfoSlider = mysensors [2];
      DistVal = mysensors [3];
      VisChoice = mysensors [4];
      println(LoudVal, '\t',
      InfoButton, '\t',
      InfoSlider, '\t',
      DistVal, '\t',
      VisChoice);
      }
    }
  }
}


void draw() {
      readArduino();
      videoChoice();


       if (LoudVal<=255) {
         displayedMovie = movieQuietOkay[videostate];
         displayedTitle = titleQuietOkay[videostate];
         displayedMovie.loop();
       } else if (LoudVal > 255 && LoudVal < 511) {
         displayedMovie = movieLoudOkay[videostate];
         displayedTitle = titleLoudOkay[videostate];
         displayedMovie.loop();
       } else if (LoudVal > 512 && LoudVal < 730) {
         displayedMovie = movieQuietNotOkay[videostate];
         displayedTitle = titleQuietNotOkay[videostate];
         displayedMovie.loop();
       } else if (LoudVal > 731 && LoudVal < 1050) {
         displayedMovie = movieLoudNotOkay[videostate];
         displayedTitle = titleLoudNotOkay[videostate];
         displayedMovie.loop();
       }
  image(displayedMovie, 0, 0);

  if (DistVal >= 300){
  image(displayedTitle, 0, moveY);

//  if(moveY <= 0)
//  moveY -= 50; }
//  if(moveY == 0){
//  moveY += 50; }


 if (DistVal <= 300){
 // tint(255, transparency);
  transparency -= 50;
  }

  else{
  }
}

void movieEvent(Movie displayedMovie) {
  displayedMovie.read();
}
```

Max MSP patch



A20. Research 4: Respondent form

Research respondent form

name _____ age _____

gender _____ date _____

signature _____

by participating in this test I agree that the results are used for the benefit of Roel Redert his graduation. No results will be trackable directly back to me (the participant) but some images may be made of me using the designed product. These migth be used in the report for educational purposes. Your signature indicates that you have read and approve of these terms of participation.

participant number

What is the first link that the participant thinks is created with Doplor?

Do participants understand the link between the visualisations and the auditory environment?

Yes | No

What state would the participant give to the first quiet visualisation?

Quiet | Loud | Why?

Do participants understand the link between the visualisations and the auditory environment?

Yes | No

What state would the participant give to the first quiet visualisation?

Quiet | Loud | Why?

What has been the main contribuant to the sound pollution and how long did it averagely take?

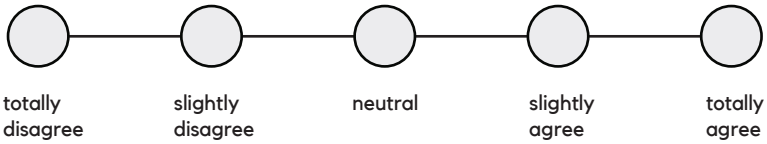
I think that the visualisations shown were friendly and kind.

totally disagree — slightly disagree — neutral — slightly agree — totally agree

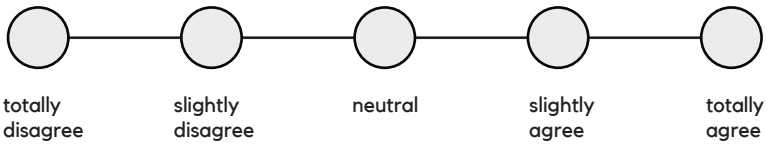
This design would help me understand the auditory environment easier.

totally disagree — slightly disagree — neutral — slightly agree — totally agree

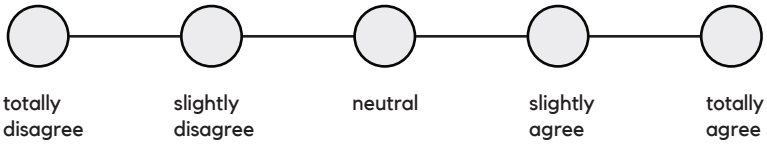
The way of interacting with this design was intuitive.



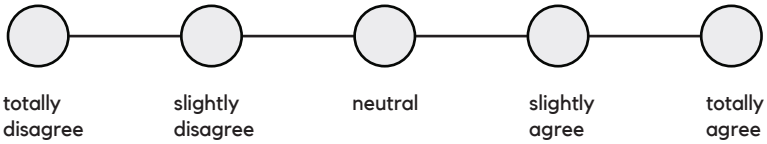
I would act more quiet with this design being around.



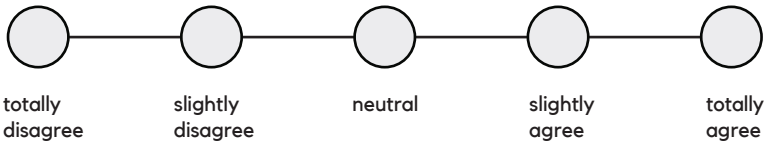
I did not gain enough information about the different sound disturbing factors.



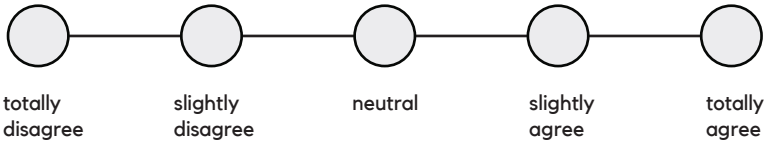
This design would easily get me bored.



The visualisations showed no clear relation to the sonic environment.



I would feel monitored with this design in my workspace.



If you would have to change one aspect of this design, what would it be?

If you have any remarks left please leave them here:

A21. Research 5: Respondent form

Research respondent form

Dankjewel dat je mee wilt doen met mijn test! Tijdens deze test zal ik vragen om eerlijk te antwoorden op stellingen die te maken hebben met mijn ontworpen product: Doplor. Dit zijn vragen die deels over het uiterlijk, maar ook voornamelijk over de werking van mijn product gaan. Je mag altijd op ieder moment stoppen met de test, het zal niet veel langer duren dan 5 tot 8 minuutjes.

participant number

Nu je Doplor voor het eerst ziet, wat denk je dat zijn functie is?
What is the first link that the participant thinks is created with Doplor?

What has been the main contribuant to the sound pollution and how long did it averagely take?

Wat voelde je toen je naar deze visualisatie keek?

VISUALISATION 1

Op een schaal van 1 tot 7, hoe ... vind je het prototype
What do you feel when you see this visualisation?

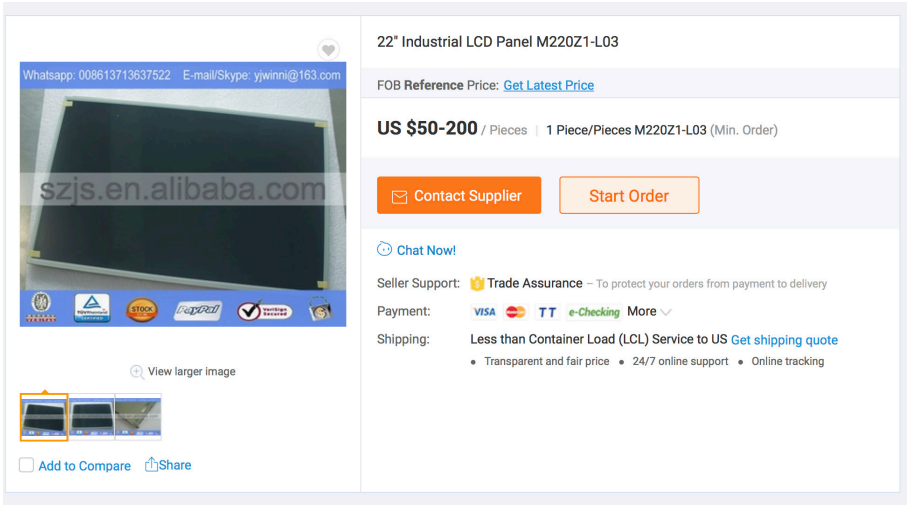
	1	2	3	4	5	6	7
Ruig *hostile*	Helemaal niet ruig			neutraal			Heel erg ruig
Druk *busy*	Helemaal niet druk			neutraal			Heel erg druk
Vriendelijk *friendly*	Helemaal niet vriendelijk			neutraal			Heel erg vriendelijk
Rustgevend *soothing*	Helemaal niet rustgevend			neutraal			Heel erg rustgevend
Toegankelijk *approachable*	Helemaal niet toegankelijk			neutraal			Heel erg toegankelijk
Kalm *peaceful*	Helemaal niet kalm			neutraal			Heel erg kalm
Activerend *activating*	Helemaal niet activerend			neutraal			Heel erg activerend

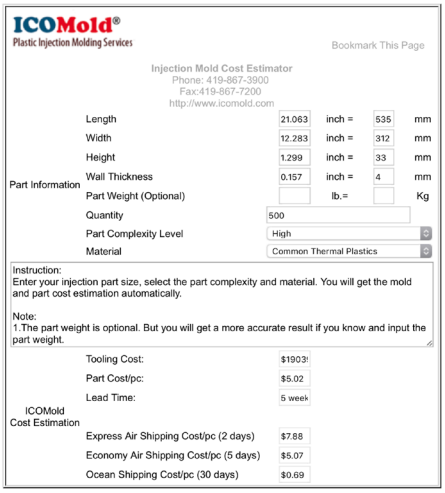
Ik zie een zeer duidelijke relatie tussen de video's en de geluidsomgeving.

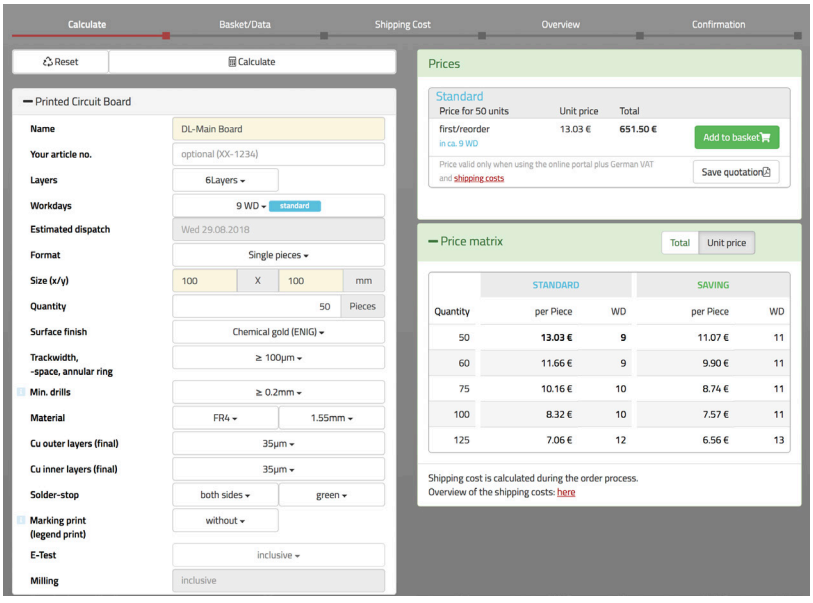
7 — 4 — 1

Ik zie helemaal geen relatie tussen de video's en de geluidsomgeving.

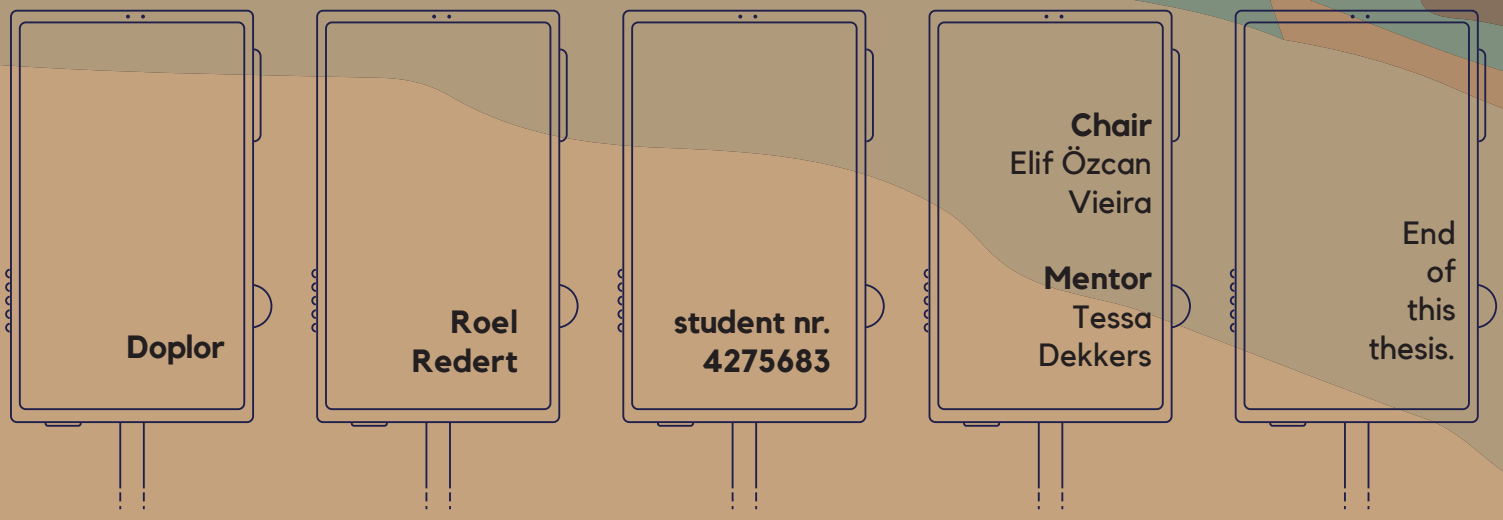
A22. Screenshots for price calculations







Thank you for reading me.

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