Final report

Project IPD 7: Interactive Silent Drums

Date: 27-01-2009

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Strategy and target group

Target Group

In the first place the project has been aimed at deaf and hearing impaired people. Special schools and institutes for these people will be able to give music lessons in the future. This in order to teach them through meaning of feeling and seeing music.
Furthermore it is also a method of music lessons for hearing children. This is a playful way of teaching rhythms to young children.

Goals

Main aim of the project is to let deaf people experience music by means of feeling and visual indicators. All of this to make it better possible for these people to effectively experience and learn how to play music. Converting music into light and vibrating signals is the challenge we are facing in this project.
An extra option for our product is to let hearing children experience music in a different and playful way. Letting them use all senses will give music lessons a whole other dimension which makes it al lot more interesting to learn rhythms.

Task

Our project group is going to do research and eventually make a drum kit equipped with light and vibrating elements for deaf people. We're going to use a drum computer with an extra interface for these features.
Using research, in terms of interviews, we want to include deaf people and experts on this project to be able to make this product as suitable for this target group as possible.

Strategy

Seeing the fact that we are operating for a one-man company we are going to look at market needs, opportunities, goals, financial resources and company's capabilities. We think it is wise to follow the low development cost strategy. This strategy focuses on minimizing development cost or developing products within a constrained budget.

Another reason for this approach is that it's going to be a product especially for deaf people so there won't be any form of mass production. Our constituent does not have profit as a main target. So we have to produce this prototype with as less cost as possible.
Main targets are product performance, innovation, cost and reliability.

Patent research

There are several patents already registered in the online database which concern deaf people playing music instruments. Our principal has registered a patent himself. This patent is shown below. Mr. Peters, describes a method for deaf people to experience music. A device to accomplish this isn't described in the patent.

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(73) Octrooihouder(s): **Petrus Hubertus Peters te Rijkevoort.**

(72) Uitvinder(s): **Petrus Hubertus Peters te Rijkevoort**

(74) Gemachtigde: **Geen**

(54) **Geluid-gevoel pads voor dove mensen.**

(57) Met de uitvinding wordt beoogd omgevingsgeluiden voor dove mensen voelbaar te maken Het betreft natuurlijke geluiden om ons heen maar ook geluidsignalen van elektronische apparatuur zoals computer, tv, cd en dvd etc.. Geluidswaarnemingen waarbij geluiden trillen in pads worden voelbaar door aanraking met de huid. Door de pads in een inrichting te plaatsen zijn er verschillende gebruiksmogelijkheden: vingertoppen, achter het oor en de pols. Door in iedere inrichting de pads zo te plaatsen van laag naar hoog leert de dove mens het verschil in het aantal trillingen te onderscheiden.

The following patent is from the U.K. and is a similar idea. The sound is converted into vibrations. The idea is almost the same as the one from Mr. Peters.
On the next page you can find the patent with drawings. Also, no device is described in the patent, only tools that can be part of that device.

(12) UK Patent Application (19) GB (11) 2 231 191 (13) A

(43) Date of A publication 07.11.1990

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(58) Field of search
UK CL (Edition J) A3V, G5J JESD, H1N NAX
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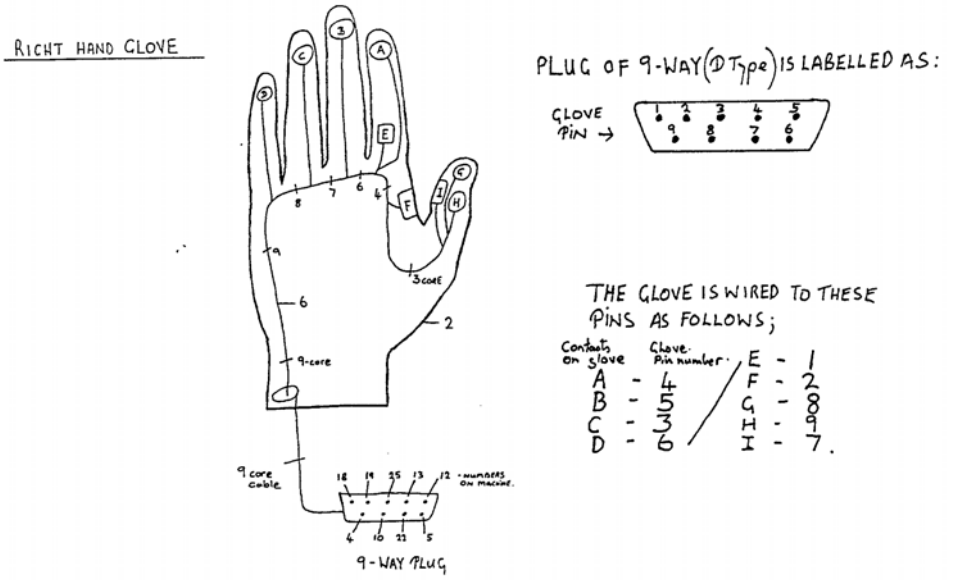
(54) A device for facilitating communication by a person

(57) A device for facilitating communication by a person, e.g. playing of a musical instrument. The device comprises a number of electrical contacts A-I disposed on a hand of a person. The electrical contacts are coupled to the musical instrument which is at a remote location. Preferably the musical instrument comprises a drum machine and a keyboard. The wearer of the device, by moving the fingers to touch the thumb, enables contacts to touch, triggering a drum sound or note of the musical instrument. Players are freed from remaining stationary whilst playing the musical instrument. Furthermore, the device enables a player to easily and quickly learn how to play a musical instrument without having to know the playing technique associated with the particular musical instrument. Instead of a musical instrument, a dog whistle, an audio or visual display, or a pyrotechnic device may be triggered. The device may be used for communication by blind, deaf and dumb persons.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 231 191 A

Competitor analysis

With this analysis, the competitors on the market are being researched. The important aspect with this research is what products the competitors produce, what strategy they are using and finally, is it a thread for us?

Competitors

First of all, there must be investigated whether there are companies that produce drumkits for deaf people. Internet news articles are explored and there was a similar school project in the United States. There assignment was approximately the same as our project, with almost the same goals, but not specific for a drumkit. When searched for companies that produce similar products, there is only Yamaha who produces drumkits with additional light signals, but there is no attention for deaf people in the product.

Products competitors

The project group from the United States have come to a product on the end of the line. They have come up with “The Silent Rhythm Teacher”. This product converts MIDI signals to light bars on a LCD screen. No LED’s or vibrations motors were used.
So far this products is not put into production by any companies, so it is still a prototype. It is also not a drumkit, but only a MIDI converter.
The product from Yamaha, mentioned before, is a drumkit with light signals behind every drum part. The price of this product is very high, about 2000 Euros.

Strategy competitors

The students of the Silent Rhythm Teacher do not have a similar product like ours, so they won’t produce a drumkit for deaf people. What there product does, is teaching rhythms to deaf people and there is no drumkit designed. Therefore, there is no reason to assume that these students are planned to produce a similar drumkit like ours.
For so far it can be researched, Yamaha has no intentions on producing any drumkit for deaf people. The additional light signals are only meant to create more sensation for a normal drum player.

Conclusion competition

As concerned for the competition, there is nothing to fear. No other companies, as we know, are producing drum kits for deaf people. If we are planning to take our prototype on the market, there shouldn’t be any issues concerning the competitors.

Technical feasibility

For the design of a drum for the deaf, there are several possibilities. The first option is to use analog electronics to create sensors and using these sensors to send light and vibration. It is also a possible to do this with a digital protocol, MIDI. This is basically what we have chosen, because it is a standard protocol that is used all over the world. This will allow our unit to work at each instrument with a midi output. This way, we create a kind of universal device, which is obviously quite useful for music schools, because they do not need to purchase new equipment.

MIDI

The first byte is the control byte. Of this byte, the first 4 bits are the command, for example “note on” or “note off”. The other 4 bits shows which channel the instrument has. This can be from 1 till 16. The second byte is the key note number byte, this byte shows what instrument it is. For example, whether it is a snare drum or a bass drum. The third byte is the byte that shows the velocity, thus it gives the loudness of the stroke and this can range from 0 to 127. What we are mainly interested in, is the note on and note off commands and the velocity with the instrument number. These show the kind of instrument and the stroke. The channel is not important for us, so we will mask this.

Microcontroller

To use the protocol, we will use the serial RS232 protocol with a custom baudrate. We will change the baud rate in the baud rate generator to 31,250 baud, this means that the microcontroller expects 31,250 bits per second.
The microcontroller that we will be using, is a Atmel controller. This, for the simple reason that our projectgroup has the most experience with this controller. There are good libraries available and a free c-compiler. The type of microcontroller that we use is a Atmel Atmega 128. Of this device, we have an evaluation board, so the software can be tested quickly. The big advantage is of course the price of the microcontroller speed. Also the options I2c, PWM, 2x UART controller, etc. are big advantages. Unfortunately, there are only 4 separate PWM outputs. This must be solved with a separate driver that drives the LEDs and vibrating motors with PWM. We have opted for PWM, because it is easy to arrange so we can dim the LEDs very well and responses good to hard strokes with powerful light. The same also applies to the vibrating motors, but then with vibrations.

Driver

The driver that we are going to use is a TLC59116. The advantage of this driver is that it works on I2c. The advantage of I2C is, that only 2 lines needed for this driver. This saves a lot of design work and traces on the print. Another advantage to this driver is that the last 4 bits of his address, can be set with hardware. Like this, we can set more of these IC `s on this bus, without causing trouble and so it is easily expandable. This IC regulates 16 individual PWM signals itself. The only thing the microcontroller does, is sending what percentage of the PWM signal should be on a certain pin. This takes over a lot work from the microcontroller.

The price of this driver is of course also not high, this is around 3 Euros. To protect this driver against the current that will run trough the engine and led `s, we use another IC buffer, ULN2003.

LED

For the visual impact of the drums, we are using 3W powerLEDs. We are using a LED, because it reacts quickly, it has no maintenance and is just as expensive as a lamp. When we work with a LED, we have of course a big advantage; there is no need to be switched to 220V, which also makes the prints a lot safer and cheaper. A relais or a good transistor is not cheap nowadays. In a cabine 2 powerLED`s are placed with a lens on top of them, this reduces the angle of the LED's to 120 degrees. When put on the 2 LED's next to eachother, we can mix colors and every part of the drumkit can have it's own kind of color. This LED`s consume about 5V in voltage and maximum with maximum powering, it will consume about 750mA. This means that the LED must be cooled with a cold body.

Vibration motors

The principal supplied us with several vibrating motors. The purpose of these motors is to put them in a sort of belt, allowing the deaf people to feel the drums instead of hearing it. Through different type of vibrating motors, being used at different places, we are trying to show the deaf people which part of the drum is activated.
Each motor type has a different frequency and amplitude, with the same voltage. When we vary the voltage, we will create a different frequency and amplitude gain, which we can indicate different intensities.
The producer of such motors is Precision Micro Driver. In total we have 4 different types of motors supplied received from the principal, Mr. Peters.

Essential choices

During the project some choices are made, each with their own reasons. The most important choices are shown below with the reason why that choice is made.

Light units

At the beginning of the project the Mr. Peters only demanded 8 pads on the device. We finally chose for 10 pads because of the compatibility with the drum kit. The drum kit itself also has 10 pads, so it is a lot easier to just copy that. This way, all users can play the drum kit and not only the beginning player.

Number of LED's per pad

The number of LED's per pad are 3 now, this way the light pad can be seen through the whole classroom in a group lesson. Mr. Peters concluded at the first audit that 1 LED per pad wasn't enough for this purpose.

Vibration belt

After the interview with music teacher Max Verdoes it became clear that people with a hearing aid can feel music very good without any vibration motors. All it took was a big speaker to transmit the vibrations. Finally, we chose for a vibration belt, because this was Mr. Peters original idea and he tested this idea. The speakers can always be connected to the drum kit, so the possibility to feel trough the speakers is always there. That is the reason why we decided to make the belt and when testing the prototype the right way can be discovered.

The casing

The casing of the prototype is made out of wood, because of the easy production of it. When the product is going to be sold on the market, the casing is probably made out of plastic. This is because of the cheap production method for larger series of products and the better looks of it.

QFD - Quality Function Deployment

Identification and structuring customer wishes

In the first place the project has been aimed at deaf and hearing impaired people. Special schools and institutes for these people will be able to give music lessons in the future. This in order to teach them through meaning of feeling and seeing music.
Furthermore it is also a method of music lessons for hearing children. This is a playful way of teaching rhythms to young children.

Goals

Main aim of the project is to let deaf people experience music by means of feeling and visual indicators. All of this to make it better possible for these people to effectively experience and learn how to play music. Converting music into light and vibrating signals is the challenge we are facing in this project.
An extra option for our product is to let hearing children experience music in a different and playful way. Letting them use all senses will give music lessons a whole other dimension which makes it al lot more interesting to learn rhythms.

Strategy

We don't have any comparing material because there are not yet products of the same calibre as our product. So a concurrent strategy in this stage isn't possible for us.

System specifications

Here are specified the requirements and specifications of our project. The first part exists out of requirements. These were specified in accordance with our client.

Functional requirements:

- Input is conform MIDI protocol.
- The signal is translated to Light and vibration.
- LEDs are used instead of normal bulbs.
- We need multiple LEDs for strong light output.
- We want to generate vibration with vibrating motors.
- The First prototype is based on a basic drum set up.
- From the DD-65 kit one is used

Non functional requirements:

- The client wants to use the prototype during individual lessons and group lessons.
- The controller needs to be as universal as possible.
- The LED module is based on the Yamaha DD-65. The module needs to have the same lay-out.

Specifications
The specifications consist of two parts. The First part are the written specs, the second part is a schematic overview view.
Our system is build of the following parts:

Controller
The controller is used for reading the MIDI signal, storing it and to translate it into usable output. This output is used by the LED module and used by the vibration module.

LED module
The LED module converts sound to light.

Vibrato module
The vibrato module converts sound to feeling, with use of vibrations.

Input
Signal according to MIDI protocol

Bytes that are used:
Channel
Note
Velocity
Generated by DD-65.
Drumkit 1 is used by prototype controller.

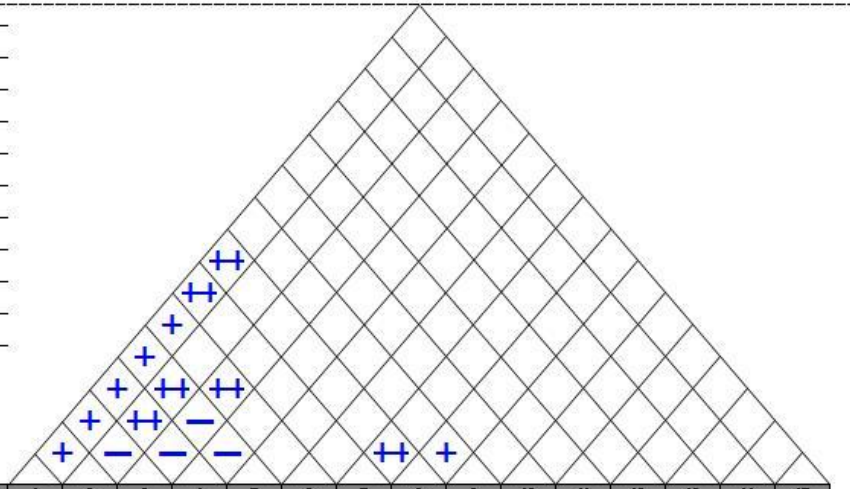
Output
LED module
7 different color LED.
Distance between LED and outside has to be 8 cm.
There are 10 pads that need to be lid.
Double color for hi-hat.
Different working Voltages for LEDs. Maximum Voltage: 12V

Vibrato module
Needs to be carried around the abdominal.
The vibrators are place on different places for different drums.
Also there is a different compound.

Power supply:
Different output Voltages: 12V and 5V.
Peek power of 120W.
Peek current of 10A.

On the next page we have filled out an QFD diagram with the specifications set up by our principal and the functional requirements. (Competitive analysis we could not fill out because there is no product yet like our product, so there is not yet any competition.)

Title: QFD IPD group 7
Author: Maarten Staal
Date: 29-10-2008
Notes: Project: drum kit for deaf people

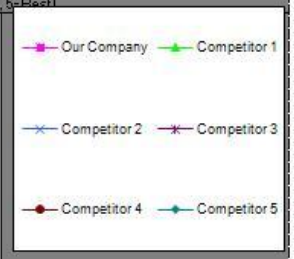


Legend

⊙	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1
++	Strong Positive Correlation	
+	Positive Correlation	
−	Negative Correlation	
▼	Strong Negative Correlation	
▼	Objective Is To Minimize	
▲	Objective Is To Maximize	
X	Objective Is To Hit Target	

Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Quality Characteristics (a.k.a. "Functional Requirements" or "Hows") / Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	1 Input is conform MIDI protocol	2 MIDI signal is converted in light	3 MIDI signal is converted in vibrations	4 LEDs are used instead of normal bulbs	5 Multiple LEDs for strong light output	6 Use vibrating motors	7 Basic drum set-up	8 DD-65 drum kit is uesd	9 Housing made of wood, same shape as drum kit	10	11	12	13	14	15	Our Company	Competitor 1	Competitor 2	Competitor 3	Competitor 4	Competitor 5
				Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15						
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	▲	▲	▲	X	X	X	▼	▼														
1	9	13,5	5,0	Light signals when drumpad is hit	⊙	⊙																				
2	9	10,8	4,0	Variation in lightintensity when drumpad is hit hard or soft	⊙	⊙			⊙																	
3	9	8,1	3,0	Different colors per pad		▲		⊙																		
4	9	13,5	5,0	Vibration when pad is hit	⊙		⊙			⊙																
5	9	10,8	4,0	Different vibration depending on pad	⊙		⊙			⊙																
6	9	13,5	5,0	Light and vibrations at same time	⊙		⊙	O		O																
7	9	10,8	4,0	Individual education		⊙		O	▲		⊙	O	O													
8	9	8,1	3,0	Classical education		⊙		O	⊙			O	O													
9	3	5,4	2,0	Easy to transport							O		O													
10	3	5,4	2,0	Easy to connect	O						O		O													
				Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)	8	8	8	5	3	6	3	3	3													
				Max Relationship Value in Column	9	9	9	9	9	9	9	3	3													
				Weight / Importance	575,7	397,3	340,5	170,3	181,1	259,5	129,7	56,8	89,2													
				Relative Weight	26,2	18,1	15,5	7,7	8,2	11,8	5,9	2,6	4,1													

Competitive Analysis (0=Worst, 5=Best)



Conclusion QFD

The QFD shows that the most important point of our project are turning MIDI signal into light and vibrations. The interface of the light panel will be the same as the interface of our drum kit. This in order to make it easy to see which pad on the drum kit corresponds with which light on the interface. Also we have to test the best possible ways of experiencing the vibrations. After an interview with an expert in the field of music for deaf people we think vibrating motors aren't the best possible way of experiencing vibrations. Probably amplifiers are a better option.

If we sum up the most important point we see:

- MIDI signal has to be converted into light and vibrations;
- Interface of light panel same as drum kit;
- Possibly amplifiers instead of vibrating motors;
- Light in different colors and intensities for optimal experience;
- LEDs instead of normal bulbs for direct effect;
- Light and vibrations at the same time when pad is hit;
- Different vibration intensities depending on pad;
- Teaching has to be possible classical as well as individual.

These are the most important points and together with our specifications we can make our prototype for our customer.

Failure Mode and Effect Analysis

A Failure Mode and Effect Analysis is needed to prevent possible failures of the product. To do this, a design FMEA can be done by looking at the following components:

o Functions
o Possible failures
o Possible causes
o The effect of the failure
o Detection of the failure

Functions
The drum kit for deaf people has the following functions:

- Responding to the MIDI with light signals
- Responding to the MIDI with vibration signals.
- Show what pad has been activated with light
- Show what pad has been activated with vibration
- Show the strength of the strike with light
- Show the strength of the strike with vibration
- Show the length of the strike with light
- Show the length of the strike with vibration
- Play a example on the pads with light and vibration.
- Must be used to teach classical lessons

Possible failures
There are several possibilities for the function failures:

<u>Failure of: Responding to the MIDI with light signals</u>
The reaction time of the light can be too slow to react at the quick strikes of the drums.

<u>Failure of: Responding to the MIDI with vibration signals</u>
The reaction time of the vibration can be too slow to react at the quick strikes of the drums.

<u>Failure of: Show what pad has been activated with light</u>
It can be hard to see what pad is corresponding with what pad of the strike.

<u>Failure of: Show what pad has been activated with vibration</u>
It can be hard to feel what pad is corresponding to what pad of the strike.

<u>Failure of: Show the strength of the strike with light</u>
It is possible that the strength of the strike is not visible on the pad.

<u>Failure of: Show the strength of the strike with vibration</u>
It is possible that the strength of the strike cannot be felt on the body.

Failure of: Show the length of the strike with light
The length of the light signal could be shorter or longer then the MIDI signal.

Failure of: Show the length of the strike with vibration
The length of the vibration could be shorter or longer then the MIDI signal.

Failure of: Play a example on the pads with light and vibration
The example program cannot be shown on the drum kit.

Failure of: Must be used to teach classical lessons
The students could be having trouble seeing or feeling the signals.

Possible causes

Causes failure: Responding to the MIDI with light signals
The light source that is being used can have a slow reaction time.

Causes failure: Responding to the MIDI with vibration signals
The vibration motors that are being used can have a slow reaction time.

Causes failure: Show what pad has been activated with light
The light signals can be mixed or look the same and so no difference can be seen.

Causes failure: Show what pad has been activated with vibration
The vibration motors have the same strength and can be mounted on a wrong place, for example too close to each other.

Causes failure of: Show the strength of the strike with light
The light source is not variable, so no strength difference can be seen.
The signal can be too weak to let the light source react.

Causes failure: Show the strength of the strike with vibration
The vibration motor are not variable, so no strength difference can be felt.
The signal can be too weak to let the vibration motor react.

Causes failure: Show the length of the strike with light
The light signal could react longer or shorter on the MIDI signal.

Causes failure: Show the length of the strike with vibration
The vibration signal could react longer or shorter on the MIDI signal.

Causes failure: Play an example on the pads with light and vibration
The input signal cannot be recognized or is badly transformed by the device.

Causes failure: Must be used to teach classical lessons
The light and vibration signals are too weak to be seen by the students.

Effect of failure

Effect failure: Responding to the MIDI with light signals
The LED is responding later then the strike.

Effect failure: Responding to the MIDI with vibration signals
The vibration motor is responding later then the strike.

Effect failure: Show what pad has been activated with light
The pads have almost the same color or the wrong LED's are on.

Effect failure: Show what pad has been activated with vibration
The vibrations feel the same and no difference can be made.

Effect failure: Show the strength of the strike with light
No strength difference can be seen. The signal can be too weak to let the light source react.

Effect failure: Show the strength of the strike with vibration
No strength difference can be felt. The signal can be too weak to let the vibration motor react.

Effect failure: Show the length of the strike with light
The LED's turn on longer or shorter then they suppose to be.

Effect failure: Show the length of the strike with vibration
The vibrations are longer or shorter then they suppose to be or don't respond.

Effect failure: Play an example on the pads with light and vibration
The sample is wrong or doesn't play at all.

Effect failure: Must be used to teach classical lessons
The light signals can't be seen by the students.

Detection of failure

Detect failure: Responding to the MIDI with light signals
The light isn't synchronal with the strike and that delivers a delay.

Defect failure: Responding to the MIDI with vibration signals
The vibrating feeling is delayed with the strike.

Detect failure: Show what pad has been activated with light
The wrong lights are on when playing drums.

Detect failure: Show what pad has been activated with vibration
The vibration feeling is the same all the time.

Defect: Show the strength of the strike with light
No difference can be seen in the strength of the light.
Defect failure: Show the strength of the strike with vibration
No strength difference can be felt in the strength of the vibration.

Detect failure: Show the length of the strike with light
The LED's aren't turned on the same length as the strike.

Detect failure: Show the length of the strike with vibration
The vibration is too long or too short. There is no vibration.

Detect failure: Play an example on the pads with light and vibration
The example rhythms isn't shown right.

Detect failure: Must be used to teach classical lessons
The students can't follow the rhythms.

Value for reliability

In order to get a value for the reliability of the product, an excel sheet is filled in to calculate the risk on the next page.

Each factor is given a certain value and so ultimately the reliability of the product is converted into a value. This can be seen in the table in the annex.

FMEA ☐System ☑Design ☐Process

Document name: **Drumkit for deaf people** Date 25-11-2008

RPN 200 -
RPN 100 -199
RPN 1-99

Pos.	FUNCTION	POTENTIAL FAILURE MODE	POTENTIAL CAUSES	POTENTIAL EFFECTS	DETECTION METHOD	SEV	OCC	DET	RPN	Recommended Action(s)
1	**Responding to the MIDI with light signals**	The reaction time of the light can be too slow or no light at all	The light source can have a slow reaction time.	The LED is responding later then the strike.	The light isn't synchronal with the strike and that delivers a delay	8	3	4	**96**	Replace LED's or rewrite program
2	**Responding to the MIDI with vibration signals**	The reaction time of the vibration can be too slow or no vibration at all.	The vibration motors can have a slow reaction time.	The vibration motor is responding later then the strike.	The vibrating feeling is delayed with the strike.	8	3	4	**96**	Replaxe motors or rewrite program
3	**Show what pad has been activated with light**	Hard to see the difference between the light signals	The light signals can be mixed or look the same and so no difference can be seen.	The pads have almost the same color or the wrong LED's are on.	The wrong lights are on when playing drums.	7	4	3	**84**	Better isolated pads, check connections, check program.
4	**Show what pad has been activated with vibration**	Hard to feel the difference between the vibrations	The vibration motors have the same strength and can be mounted on a wrong place	The vibrations feel the same and no difference can be made	The vibration feeling is the same all the time.	7	6	4	**168**	Replace the pads on the body, replace motors, rewrite program.
5	**Show the strength of the strike with light**	Difference in strength is not visible	The light source is not variable, so no strength difference can be seen.The signal can be too weak to let the light source react.	No strength difference can be seen. The signal can be too weak to let the light source react.	No difference can be seen in the strength of the light.	5	3	3	**45**	Rewrite program, replace LED's

6	**Show the strength of the strike with vibration**	Difference in strength is not feelable	The vibration motor are not variable. The signal can be too weak to let the vibration motor react.	No strength difference can be felt. The signal can be too weak to let the vibration motor react.	No strength difference can be felt in the strength of the vibration.	5	6	6	**180**	Rewrite program, replace pads on body, replace motors.
7	**Show the length of the strike with light**	The length of the light signal could be shorter or longer then the MIDI signal	The light signal could react longer or shorter on the MIDI signal.	The LED's turn on longer or shorter then they suppose to be.	The LED's aren't turned on the same length as the strike.	5	3	3	**45**	Replace LED's or rewrite program.
8	**Show the length of the strike with vibration**	The length of the vibration could be shorter or longer then the MIDI signal	The vibration signal could react longer or shorter on the MIDI signal.	The vibrations are longer or shorter then they suppose to be or don't respond.	The vibration is too long or too short. There is no vibration.	5	5	5	**125**	Replace motors, replace pads, rewrite program.
9	**Play an example on the pads with light and vibration**	The example program cannot be shown on the drum kit	The input signal cannot be recognized or is badly transformed by the device	The sample is wrong or doesn't play at all.	The example rythms isn't shown right.	5	4	2	**40**	Rewrite program, check compatibility drumcomputer.
10	**Must be used to teach classical lessons**	The students could be having trouble seeing or feeling the signals	The light and vibration signals are too weak to be seen by the students	The light signals can't be seen by the students.	The students can't follow the rhytms.	5	4	3	**60**	Different position, replace LED's.

Conclusion FMEA

As you can see on the FMEA chart, the most risks are coming from the vibration belt.
The main concern about the vibration belt is to feel the strength of the signal on the body and actually, that is the same problem as feeling the difference between the signals. When developing the product, this potential problem must have extra attention.

As mentioned before, the vibration belt can also be replaced with a big speaker, that off course also produces vibrations. That could solve the problem and another solution is to replace the motors on the belt, so this way the signals can be felt.

System requirement and specifications

Requirements

In this document is specified the requirements and specifications of our project. The first part exists out of requirements. These were specified in accordance with our client.

Functional requirements:

- Input is conform MIDI protocol.
- The signal is translated to Light and vibration.
- LEDs are used instead of normal bulbs.
- We need multiple LEDs for strong light output.
- We want to generate vibration with vibrating motors.
- The First prototype is based on a basic drum set up.
- From the DD-65 kit one is used

Not functional requirements:

- The client wants to use the prototype during individual lessons and group lessons.
- The controller needs to be as universal as possible.
- The LED module is based on the Yamaha DD-65. The module needs to have the same lay-out.

Specifications

The specifications consist of two parts. The First part are the written specs, the second part is a schematic overview view.

Our system is build of the following parts:

- LED module + controller

  The LED module converts sound to light.

  The controller is used for reading the MIDI signal, storing it and to translate it into usable output. This output is used by the LED module and used by the vibration module.
- Vibrato module

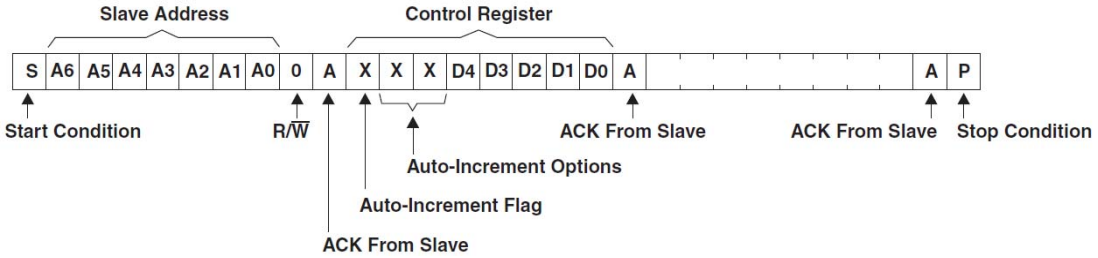
  The vibrato module converts sound to feeling, with use of vibrations.

Input

- Signal according to General MIDI protocol
- Bytes that are used:
  - Channel
  - Note
  - Velocity
- Generated by a drum computer, in test setup by dd-65.
- Every drum kit could be used.
- If the learn button is pushed, ISD will learn which code belong to which pad.

Treatment

- The treatment of the signal is done with an ATmega128 microcontroller.
- MIDI signal is stored in the memory of the microcontroller.
- The signal is stored just long enough to work with it.
- The signal is split into the three bytes that are needed.
- Microcontroller output to the LED driver is in accordance with the I2C-protocol.
- I2C command exist of :



- LED driver output is in PWM configuration.
- LED driver drives the power drivers with the PWM-signals.
- The PWM-signal has a value from 0 – 100% and with steps of 10%.
- Power driver sends the amplified PWM signal to
- Power driver drives the LED module en vibrato module.
- One signal is connected to multiple power driver inputs. This to get the required power.
- Working voltage for the microcontroller and LED driver: 5V dc. Power driver does not require power supply.

Output

- LED module
    - 6 different color LEDs.
    - Distance between LED and outside has to be 8 cm.
    - There are 9 pads that need to be lid.
    - Double color for hi-hat pad.
    - The different colored LEDs have different working Voltages.

- Vibrato module
    - Needs to be carried around the abdominal.
    - The vibrators are placed on different places for different drums.
    - The vibrating motors are in different sizes.
    - The vibrating belt could be disconnected when not used.

Power supply:

- Power supply is bought in.
- Different output Voltages: 12V and 5V.
- Peek power of 120W.
- Peek current of 10A.

Commercial plan

Target group

The audience that we want to reach are deaf and hard hearing people who are interested in music. Initially, we focus on students and/or parents of students in special education with a hearing impairment. The reason for this is the easy approach of the teachers in these special schools. If the total number of deaf students in special education are added up for the year 2007/2008, then there are 1040 students.(see appendix for the exact data)

Competitor analysis

For this part, see chapter: “Competitor analysis”.

Finding costumers

Because it is not easy to approach these students directly, there is contact with teachers on this special schools. Furthermore, the teacher might find it a good tool for teaching and can get interested.
Once there is contact with the students is through this channel, we can think bigger and adults with hearing impairment can be approached. With more than 1.5 million adults with a severe hearing problem, this is a big market. After that, the world lies ahead.

Promotion

As already said, the introduction of the product will go through the education. The music teachers of special deaf schools will be asked to agree for a demonstration of the product. With this demonstration, the interest of students and teachers can be generated.
When these target groups are interested, then we have to consider if they really want to buy the product. With the younger students, this process will go through the parents.
There will also be publicity generated by sending press releases to well-known Dutch newspapers and television stations. If the product is a next stage, it can also be presented on fairs and events, where the target group is involved.
We will also hand out flyers with contact and product information, so there will be a high awareness in a short time. A website about the product is also an option.

Media choice

Because the target group has little or no hearing at all, the radio is a poor medium for the promotion of the product. Therefore, the following media will be chosen:

- Magazines for people with a hearing aid
- Television programs(Hart van Nederland, Omroep Brabant)
- Websites for people with a hearing aid (www.doof.nl)
- Other main-stream websites
- Newspapers
- Fairs and events

After the prototype

When the prototype is finished and with that, the project too, what can our client do with the prototype? At first, we recommend that he gets a patent for the total product, so he is the only dealer of the product. After that, he can consider the following options:

Produce the Interactive Silent Drums itself

By producing the Interactive Silent Drums itself, is meant, that Mr. Peters is going to look for production companies which can produce the product. This is a risky project, because the investing costs are very high, for example the production of a mould is quite expensive.

Selling the idea

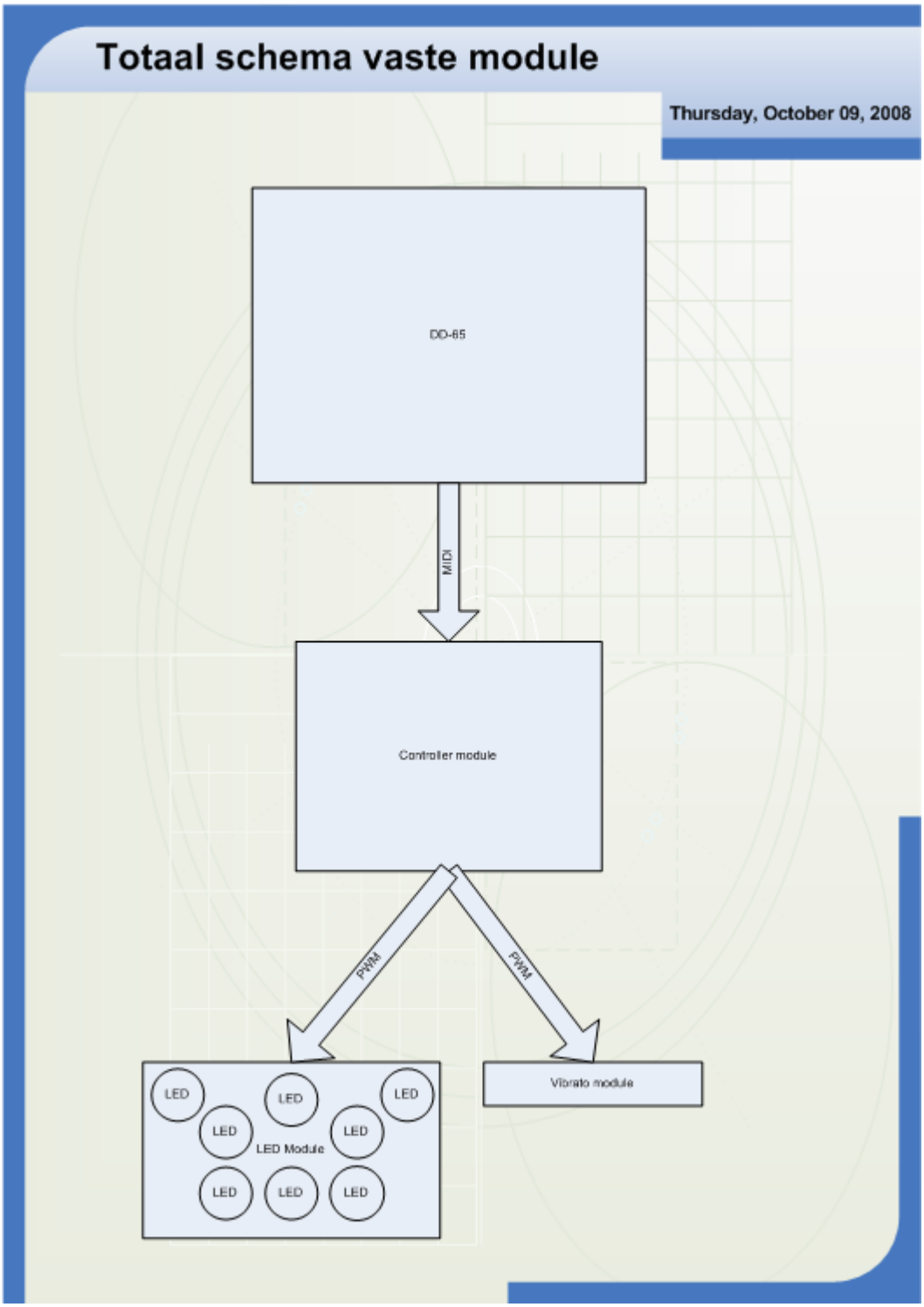
When he has the patent of the product, he can visit music instruments manufactures or other interested companies. With a signed non-disclosure agreement, Mr. Peters can discuss the option to sell the patent to the company. This way, with not much effort, money can be made and the Interactive Silent Drums are available for all people with a hearing aid. After all, this is the main goal for Mr. Peters.

Keeping costumers

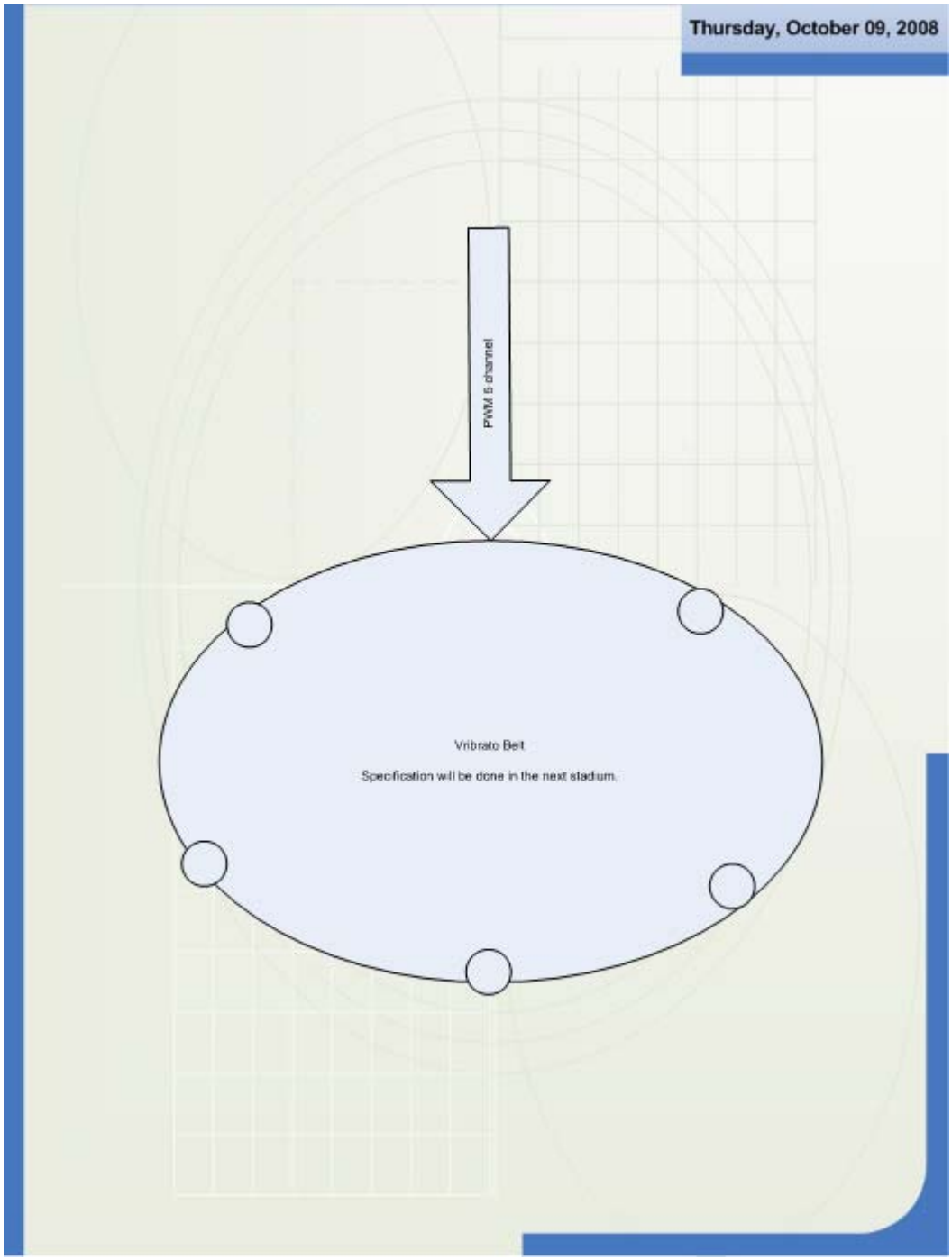
When chosen for the first option and a company is started, you have to attract and keep customers. In order to keep customers within the company, the product must be able to adapt to the customers. For example, some software made for the product, for example loading rhythms into the drumkit. Another option is to store the songs made with the Interactive Silent Drums. The hardware of the product does not have to be changed for these extra options.

Appendices

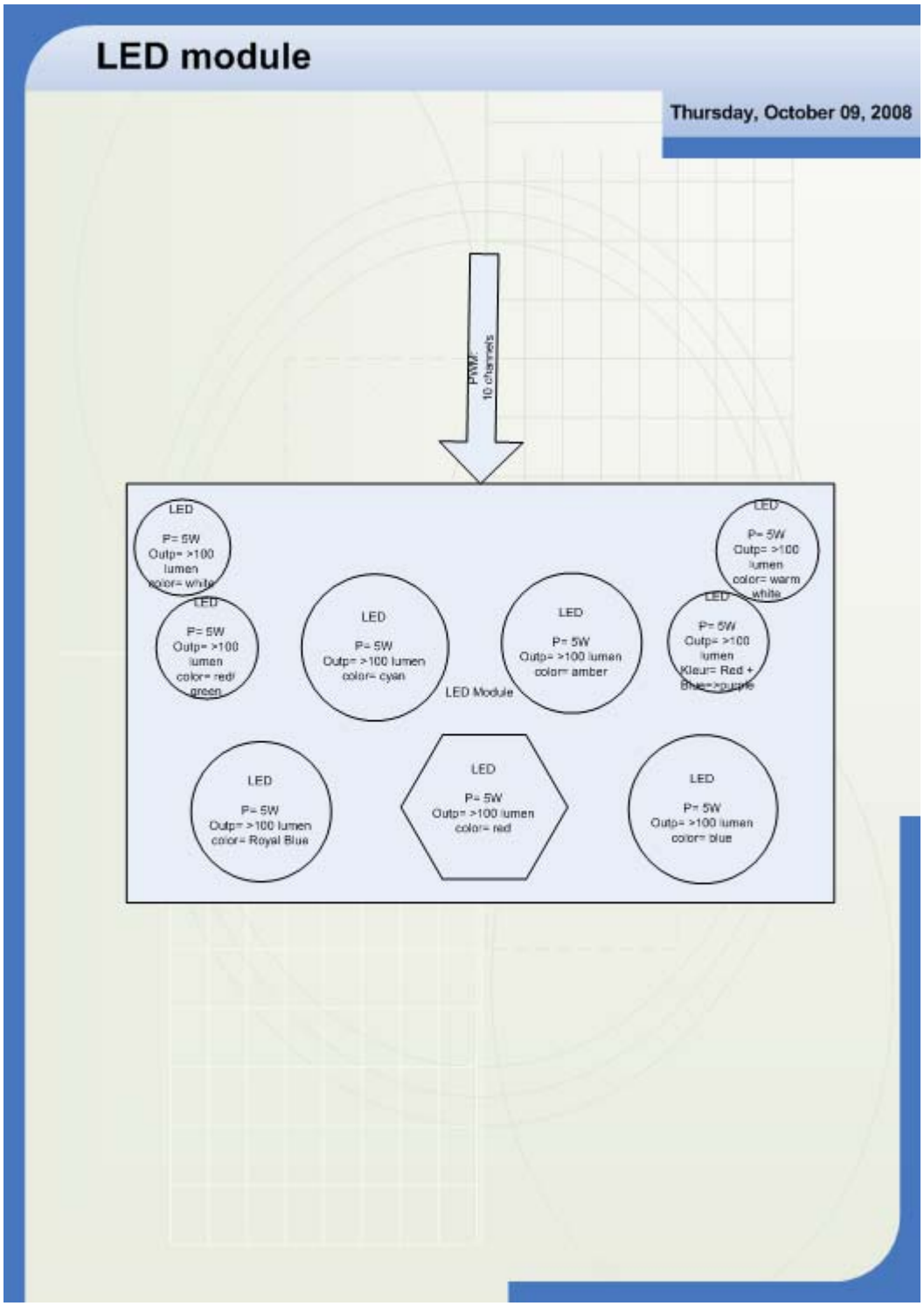
Appendix 1: Total lay-out



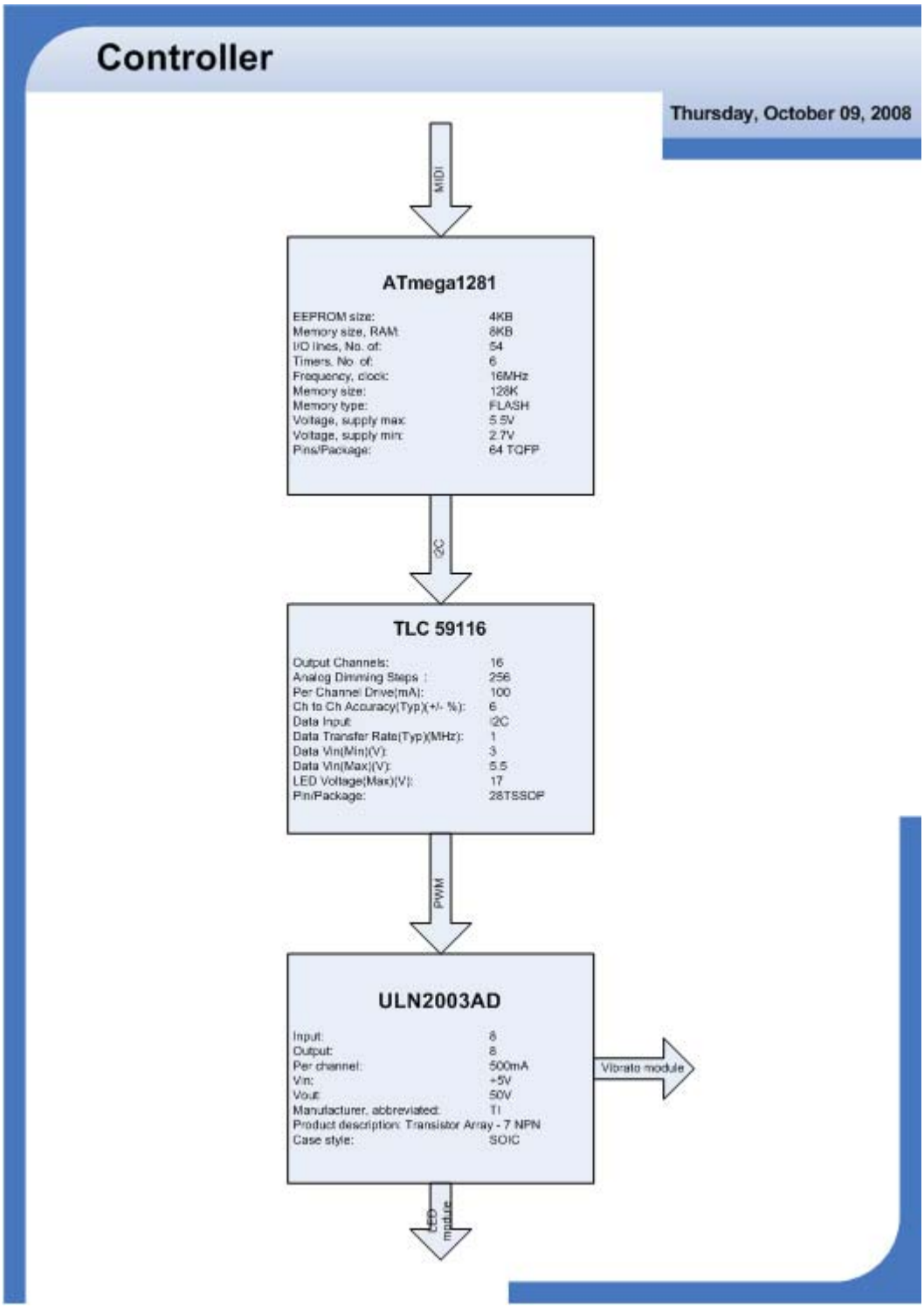
Appendix 2: Vibrato belt



Appendix 3: LED module



Appendix 4: Controller



Appendix 5: User test plan

Test # 1: Connections
With this test there can be checked if the devices are correctly wired.

Test	Past	Failed	Comment
Connection between the MIDI out of DD-65 to the MIDI in of the Controller.			
Connection between the kick pedal and the pedal 1 input of the DD-65.			
Connection between the high-hat pedal and the pedal 2 input of the DD-65			
Connection between the controller and the vibration belt.			
Connection between the controller and the light module.			
Connection between the Yamaha power supply and the DD-65			
Connection of the Yamaha power supply to the net.			
Connection between de powersupply and the controller.			

Test #2:
With this test can be checked if the DD-65 is working correctly.

Test	Past	Failed	Comment
After you pressed the standby/on button on the DD-65, the message dd65 should appear on te display.			
After waiting 30 seconds maximum, the message 001 needs to be displayed on the display.			
Check if drumkit 1 is selected.			If not, change drumkit to drumkit 1, by pressing the kit button on the DD-65, the number that appears is the actual drumkit. Change it by turning the dial.

Test #3:
With this test the function of the controller and light module can be tested.

Test	Past	Failed	Comment
When hitting Small Pad 1, Small Light 1 should lid. The intensity of the light depends on how hard the pad is hit.			
When hitting Small Pad 2, Small Light 2 should lid. The intensity of the light depends on how hard the pad is hit.			
When hitting Pedal 2, Small Light 2 should lid in another collor then when hitting Small Pad 2. The intensity of the light depends on how hard the pad is hit.			
When hitting Small Pad 3, Small Light 3 should lid. The intensity of the light depends on how hard the pad is hit.			
When hitting Small Pad 4, Small Light 4 should lid. The intensity of the light depends on how hard the pad is hit.			
When hitting Pad 1, Light 1 should lid. The intensity of the light depends on how hard the pad is hit.			
When hitting Pad 2, Light 2 should lid. The intensity of the light depends on how hard the pad is hit.			
When hitting Pad 3, Light 3 should lid. The intensity of the light depends on how hard the pad is hit.			
When hitting Pad 4, Light 4 should lid. The intensity of the light depends on how hard the pad is hit.			
When hitting Pedal 1, Light 5 should lid. The intensity of the light depends on how hard the pad is hit.			

Test #4:
With this test the function of the controller and vibration module can be tested.

Test	Past	Failed	Comment
When hitting Pad 1, vibration pad 1 should vibrate. The intensity of the light depends on how hard the pad is hit.			
When hitting Pad 2, vibration pad 2 should vibrate. The intensity of the light depends on how hard the pad is hit.			
When hitting Pad 3, vibration pad 3 should vibrate. The intensity of the light depends on how hard the pad is hit.			
When hitting Pad 4,vibration pad 4 should vibrate. The intensity of the light depends on how hard the pad is hit.			
When hitting Pedal 1, vibration pad 5 should vibrate. The intensity of the light depends on how hard the pad is hit.			

Appendix 6: CBS statics: number of children on deaf schools

Schoolsoorten/clusters	Perioden	Totaal mannen en vrouwen																	
		Totaal leerlingen	Cumi-leerlingen		Leerlingen naar leeftijd														
			Cumi-leerlingen	Cumi-leerlingen in %	4 jaar of jonger	5 jaar	6 jaar	7 jaar	8 jaar	9 jaar	10 jaar	11 jaar	12 jaar	13 jaar	14 jaar	15 jaar	16 jaar	17 jaar	18 jaar of ouder
		aantal		*percentage*	*aantal*														
Dove kinderen - basis	1995/'96	350	100	28	70	40	40	40	30	30	30	40	20	0	-	-	-	-	-
	2000/'01	270	80	31	40	30	30	30	30	30	30	30	10	0	-	-	-	-	-
	2005/'06	460	130	28	100	60	50	50	40	40	40	50	30	10	0	-	0	0	0
	2006/'07	450	130	29	100	60	60	50	50	30	40	30	30	10	0	0	0	0	0
	2007/'08*	430	130	30	110	50	50	50	40	40	40	30	20	0	0	0	0	0	0
MG doof en visueel gehandicapt - basis	1995/'96	.																	
	2000/'01	.																	
	2005/'06	40	10	22	10	0	0	0	0	10	0	0	0	0	-	-	-	-	-
	2006/'07	30	10	21	0	10	0	0	0	0	10	10	0	0	-	-	-	-	-
	2007/'08*	40	10	16	10	0	0	0	0	0	0	10	10	0	0	-	-	-	-
MG doof en zmlk - basis	1995/'96	.																	
	2000/'01	.																	
	2005/'06	290	90	29	30	20	20	20	10	30	30	30	20	10	10	10	20	10	30
	2006/'07	280	90	31	20	20	20	20	10	10	30	20	20	10	10	10	10	20	20
	2007/'08*	260	70	27	20	20	20	20	20	10	10	30	20	20	10	10	10	10	20
Dove kinderen - voortgezet	1995/'96	230	70	30	-	-	-	-	-	-	-	-	10	30	20	30	50	30	50
	2000/'01	150	50	31	-	-	-	-	-	-	-	-	20	20	20	30	30	20	20
	2005/'06	220	70	34	-	-	-	-	-	-	-	-	20	40	40	40	30	20	30
	2006/'07	220	70	31	-	-	-	-	-	-	-	0	20	30	40	50	40	30	20
	2007/'08*	240	60	26	-	-	-	-	-	-	-	0	20	40	30	40	50	30	30
MG doof en visueel - voortgezet	1995/'96	.																	
	2000/'01	.																	
	2005/'06	30	0	10	-	-	-	-	-	-	-	-	-	0	0	10	10	0	10
	2006/'07	30	0	7	-	-	-	-	-	-	-	-	-	0	10	0	10	10	10
	2007/'08*	30	0	11	-	-	-	-	-	-	-	-	-	0	0	10	0	10	10
MG doof en zmlk - voortgezet	1995/'96	.																	
	2000/'01	.																	
	2005/'06	90	40	40	-	-	-	-	-	-	-	-	10	0	10	20	20	10	20
	2006/'07	70	30	45	-	-	-	-	-	-	-	-	10	10	0	10	10	10	20
	2007/'08*	60	30	47	-	-	-	-	-	-	-	0	0	10	10	10	10	10	10