Action plan

Project group 1 [EQ2]
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23 February 2015, Delft

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1 Backgrounds

BARK is a loudspeaker manufacturer that has been planning to develop a series of active speakers, using built-in power amplifiers.

It is most likely that people who will buy these active speakers, will also want to buy high-end stereo preamplifiers. These high-end stereo preamplifiers are expensive and rare. BARK has therefore decided to develop a new preamp, using standard audio devices in order to keep the preamp affordable. BARK has also decided that the speakers and its electronics have to be operated by a digital system. The features of the digital system are unknown and therefore have to be devised and designed by the project team.

BARK has little knowledge of analogue and digital electronic systems and they will therefore conduct a series of researches on various topics in order to gain knowledge and skills on these matters.

BARK has assigned this project to a project team within BARK's Electronics Division. The management of BARK wants to have a weekly update on the progress of the project. This will be done by organising meetings with the project coach, activity planning, documents and anything else that gives the project coordination team insight into the project team's progress.

The project team consists of the following members:

- Daan Conijn
- Andrew Lau
- Kevin Oei
- Koen van Vliet

The project team will be guided by a project coordination team. The project coordination team consist of six members. The six members are as follows:

- Jesse op den Brouw
- Mehmet Can
- Irma Laponder
- Frank Oldenburg
- Daniël Holt
- Martin Schröder

Section 7 contains more information about the members of the project team and project coordination team.

2 Project results

The main objective of the project is the design and realisation of an active loudspeaker as specified by BARK. The recent dramatic price drop for these type of devices is one of the reasons for the project's conception. Additionally, the setup of these speakers allow for significant advantages such as avoiding large cables, cheaper electronic circuits as well as greater simplicity in designing these circuits. On top of featuring built-in power amplifiers, BARK also requires that the loudspeaker contains a digital system which will control the entire setup (the DCU). This decision was made in light of the emerging trend of digitizing electronic products. A working demonstration model of the team's designed loudspeaker is to be presented on the 29th of June.

The following specifications and preconditions were given for the loudspeaker's components:

2.1 Preamplifier

A. Overall specifications preamplifier Balance control in flat position, tone (bass and treble) control switched off, volume control at maximum.

1. input impedance: minimum 100 k
2. output impedance: maximum 100
3. sensitivity : 2 V output voltage in R_L = 20 k at 200 mV input
4. frequency range: 2 Hz to 400 kHz (-3 dB) at V_{out} = 500 mV, R_L = 20 k
5. output voltage: at least 7 V sinusoidal with R_L = 20 k , = 1 kHz

B. Balance control specifications

1. range ś6 dB (within ś0.5 dB) difference between right and left channels
2. in flat position +2 dB (within ś0.5 dB)
3. approximate logarithmic control function
4. no DC current through the potentiometer nor the wiper

C. Bass and treble control specifications

1. treble: Cut-off frequency adjustable between 2.5 and 10 kHz. Maximum boost or attenuation 10 dB (ś1 dB) at 2.5 kHz. From 100 kHz and up the transfer function must approach value 1 (0 dB).
2. bass: Cut-off frequency adjustable between 100 Hz and 400 Hz. Maximum boost or attenuation 10 dB (ś1 dB) at 400 Hz. From 10 Hz and below the transfer function must approach value 1 (0 dB).
3. approximate logarithmic control functions for cut-off frequencies and boost / attenuation adjustments
4. no DC currents through potentiometers nor wipers
5. **option**: tone controls are switched on and off without any clicking noises from the speakers

D. Volume control specifications

1. approximately logarithmic control function
2. no DC current through the potentiometer nor the wiper

Preconditions

1. The potentiometers for balance, bass, treble and volume control are 10 k linear.
2. The potentiometers for the adjustment of the bass / treble cut-off frequencies are 10 k logarithmic.
3. All the preamplifier's opamps are low noise NE5532 type. The NE5532 is a dual opamp version of the NE5534. Both Multisim and Pspice contain suitable models for the NE5532 and the NE5534.
4. The simulation results of the sub circuits and the preamplifier are represented by the transfer function (amplitude and phase characteristics). These simulation results must be compared with the transfer function gained by measurement. Draw your conclusions.

2.2 Power amplifier specifications

The power amplifier has the following specifications:

1. input impedance at least 50 k
2. output power: 15 W sine in $R_L = 8$ at 1 kHz
3. frequency range: 10 Hz to 100 kHz (-3 dB) at $P_L = 0.5$ W in 8

For simplicity of design, the power amplifier should be a monolithic component.

2.3 Power supply

The power supply must supply all rated voltages and current in the system as to be determined by the project team. The power supply should be constructed using linear regulators. The projected efficiency should be 80% or better.

2.4 Digital Part

The functionality of the digital system is yet unknown. Since BARK mainly deals with analogue electronics systems, the company would like you to develop attractive features that have to be implemented within the duration of the project. The proposed features have to be discussed with your coach. The system should at least have

- An ATmega32 microcontroller or similar;
- Some kind of interaction with the analogue part of the system.

2.5 Final results

Apart from presenting a working demonstration model of the speaker, a final design report must be handed in on Friday 12 June no later than 17:00 in twofold to the project coordinator (Jesse op den Brouw) as well as using the digital platform Ephorus. This report must at least contain the following:

1. Summary;

2. Introduction on the subject;
3. Complete description of the problem including specifications and preconditions;
4. Design overview of the complete system (including digital part, power supply and power amplifier), including how the analog parts are controlled by the digital parts and vice versa.
5. In-depth analysis of the preamplifier with calculations, simulation and measurement results;
6. Design of the power supply;
7. Design of the digital system controlling the preamplifier;
8. Test results;
9. Costing of the complete system;
10. Conclusion and recommendations;
11. Appendices (if any).

A poster presentation needs to be prepared as well, the deadline and date for this is currently unknown.

3 Project activities

In order to achieve the desired results and goal of the project, many activities must be carried out by the group. These activities can be further specified in smaller sub-activities. The most significant (sub-)activities will be described here.

3.1 Recurring activities

Some activities will be carried out continuously or periodically. These include:

- Staying in touch with the project team through all the used communication platforms;
- Project meetings held at least once a week.
- Giving each other feedback on written documentation

3.2 Unique activities

The following activities will generally occur only once.

3.2.1 Project kick-off

- Attend the introductionary lecture;
- Getting the team together and sharing contact information, as well as discussing means of communication;
- Deciding who takes on the role of (deputy) project manager and secretary.

3.2.2 Preparations for the project

- Setting up all of the digital tools that will be used throughout the project (Telegram, GitHub, etc.);
- Creating a cooperation agreement that everyone is willing to sign;
- Writing an action plan.

3.2.3 Writing research papers

- Dividing the tasks for the creation of the papers;
- Looking into the topics specified by the project staff;
- Writing the papers and processing given feedback.

3.2.4 Working on the loudspeaker design

- Determining the requirements for the power supply;
- Designing the power supply circuit;
- Simulating the power supply circuit;
- Designing the PCB layout of the power supply circuit based on the previous activities;
- Designing the power-/preamp circuit;
- Simulating the power-/preamp circuit;
- Designing the PCB layout of the power-/preamp circuit;
- Determining the functionality of the DCU;
- Designing the DCU.

3.2.5 First assessment

- Writing the calculation report based on the made designs and the results of the simulations;
- Discussing the cooperation agreement, action plan, research reports and calculation report with the project staff.

3.2.6 Realising the loudspeaker design

- Dividing the tasks that are related to the realisation of the loudspeaker's components;
- Gathering the components needed for the power supply;
- Building and testing the power supply;
- Gathering the components needed for the power-/preamp;

- Inserting the components of the power-/preamp into the PCB's and soldering them;
- Connect any additional hardware;
- Testing the built amplifiers;
- Acquiring the MCU board for the DCU;
- Writing the firmware for the DCU;
- Wiring the DCU with the controls and other components of the loudspeaker;
- Testing the DCU;
- Acquiring the speaker itself and its enclosure.

3.2.7 The rest of the documentation

- Dividing the tasks for the measurement report
- Writing a measurement report based on the calculation report and the measurements performed on the hardware;
- Discussing the sections to include in the final design report, apart from the mandatory sections;
- Divide the tasks for the final design report;
- Writing the final design report based on all other documentation.

3.2.8 Second assessment

- Preparing the demonstration model of the designed speaker system;
- Preparing the presentation (if any) for the demonstration;
- Preparing the poster presentation;
- Preparing for possible questions posed by the staff during the assessment.

4 Project scope

The project scope is limited to researching, designing and building an active speaker system with digital control unit.

4.1 Research and design

The results of the research and design work will be shared with the client by means of three research papers and several reports.

- Speaker: The speaker is supplied by the client and therefore this part of the project requires no further research or design work.
- Power amplifier: The amplifier will be designed by the project group and needs to meet the client's specifications.
- Pre amplifier: The pre-amplifier schematics are supplied by the client. Various component values need to be calculated to meet specifications.
- Power supply: The power supply will be designed by the project group and needs to meet the client's specifications.
- Digital control unit: The functionality of this part is unknown. This needs to be discussed with the client to find out exactly what they want.

4.2 Building

The power amplifier, preamplifier, power supply and digital control unit will be assembled and tested by the project group. Test results will be shared with the client in the measurement reports.

5 Intermediate results

Table 1: Activities and their intermediate results

Code	Activities	Intermediate results
A	Kick-off project	The group classification, requirements / needs of the sponsor, the educational objective and the method of assessment is made clear.
B	Cooperation agreement	An agreement that contains the following: Contact information of all group members, time of the official meetings, the definition of unwanted behaviour in the group, possible penalties and banning of a group member.
C	Action plan	A plan in which the guidelines, information about the project and planning are documented.
D	Review cooperation argeement and action plan	An approved cooperation agreement and action plan.
E	2x Research papers	Two research papers with topics which are determined by the project staff.
F	Calculation report	Calculation and selection of a suitable monolithic power amplifier, calculation of the heat sink for the power amplifier and calculation and selection of a suitable transformer for the power supply.
G	Measurement report	The measurement reports containing the design, calculations, simulations and measurements of the following: balance control, volume control, tone control and power amplifier.
H	Draft of the final design report	A preliminary table of contents, including chapters not yet written, introduction on the subject, complete description of the problem including specifications and preconditions and a design overview of the complete system.
I	Draft of the poster presentation	-

Table 2: Activities and their intermediate results (continued)

Code	Activities	Intermediate results
J	Final design report	A design report that contains the following subjects: Summary, introduction on the subject, complete description of the problem including specifications and preconditions, design overview of the complete system, in-depth analysis of the preamplifier with calculations, simulation and measurement results, design of the power supply, design of the digital system controlling the preamplifier, test results, costing of the complete system, conclusion and recommendations and appendices.
K	Demonstration of the complete system	Demonstration of a breadboard or PCB model of the one-channel amplifier to the management of BARK. Make sure the preamplifier satisfies the given specifications.
L	Poster presentation	A poster presentation in which you and your team demonstrate the steps taken to realize the final result.

6 Quality

6.1 Preamplifier

The specifications of the preamplifier are given in the projectbook. The components must be calculated to meet the specifications and the components must be well-soldered. Multisim or Capture Lite (Orcad) can be used to verify the calculations. After the soldering is complete, the preamplifier must be tested by adding measurement points and measuring these points to verify if the preamplifier meets the required specifications. Simulations can also be used to simplify the verification.

6.2 Power amplifier

The specifications of the power amplifier are given in the projectbook. The components must be calculated to meet the specifications and the components must be wel soldered. Multisim or Capture Lite (Orcad) can be used to verify the calculations. After the soldering is complete, the power amplifier must be tested by adding measurement points and measuring these points to verify if the power amplifier meets the required specifications. Simulations can also be used to simplify the verification.

6.3 Digital control unit

The functionality of the digital control unit is unknown and therefore must be improvised and realised by the project team. The improvised features must be discussed with the project coach and the project coach must approve the improvised features before it can be realised. The digital control unit must ultimately be tested after the realisation process.

6.4 Documentation

All documents are to be written in English without grammatical mistakes. If a project member is not sure how an English word is written, they can search online, ask other project team members or consult mrs. Laponder. All documents must also be writtin in LaTeX. Every project team member must provide feedback for each other's assigned documents. The documents will be placed in the GitHub repository where the documents are accessible for every project members. GitHub is used for this project, because all documents can be easily monitored. GitHub also gives an overview of modified documents and who modified the documents. This prevents possible miscommunication between the project team members and loss in documents and information regarding the contents of the documents.

7 Project organisation

The project team consists of four sophomore Electrical Engineering students. Their names, function inside the team and contact information are as follows:

Table 3: Team members

Name	Function	Phone number	Email address
Andrew Lau	Deputy project manager	+31 6 41374476	andrewhenry92@gmail.com
Daan Conijn	Project manager	+316 18720766	daan.conijn@live.nl
Kevin Oei	Regular member	+31 6 40515193	kevin.alterative@gmail.com
Koen van Vliet	Regular member	+31 6 41791491	koen9410@gmail.com

In theory, all members will be available for communication at any time. To discuss project progress and tasks in a structured and organized way, weekly project meetings will be held on Fridays at 12:00, accompanied by the project coach. The project manager will host these meetings and guide the members through all the to-be-discussed subjects, following an agenda made for each meeting. Minutes of these meetings will be made by the deputy project manager. Both the members and the project coach will receive copies of these agenda's and minutes.

The project coordination team consists of six members, all specialized in a certain field that is relevant for this project. They can be consulted if any questions arise, problems surface, or when there is a need for advise. The project coordination team members are as follows:

Table 4: Project coordination team

Name	Function
Jesse op den Brouw	Project coordinator, project coach and consultant digital design and microcontroller
Mehmet Can	Consultant analogue design
Irma Laponder	Lecturer in English
Frank Oldenburg	Construction room supervisor
Daniël Holt	Lecturer in Project Management
Martin Schröder	Lecturer in Project Management

Progress and management of the project should be reported to the project coordinator, by means of this action plan and several reports as described in section

5. Communication with the project coordinator will be done through email. For the team's internal communication, the instant-messaging app Telegram will be used. Being cloud-based and supporting many mobile as well as desktop environments, members will not be restricted by the type of devices they have and missed messages can always be caught up with. For the creation of all documentation, LyX will be used. Its LaTeX-based nature makes it very suitable for collaboration on the same document. Finally, Git will be used in conjunction with GitHub to allow the distribution of all files and convenient collaboration on the written documents.

8 Planning

Scheduling is an important part of a project. If there is no schedule then postponements can occur in the project or conflicts may arise between the group members. The activities will be scheduled so the work can be done purposefully and successfully.

In the following tables an overview of all the activities of the project PRO-Q2 can be seen.

Table 5: Activity order and duration

Code	Activities	Lead time	After
A	Kick-off project	1 week	-
B	Cooperation agreement	1 week	A
C	Action plan	1 week	A
D	Review cooperation agreement and action plan	1 week	C, B
E	2x Research papers	5 weeks	D
F	Calculation report	5 weeks	D
G	Measurement report	7 weeks	F
H	Draft of the final design report	1 week	G
I	Draft of the poster presentation	1 week	G
J	Final design report	3 weeks	G
K	Demonstration of the complete system	1 week	J
L	Poster presentation	1 week	I

Table 6: Activity schedule

Activity (code)	Time (in weeks)	BLOK3									
Week #		1	2	3	4	5	6	7	8	9	10
A (Kick-off project)	1	X									
B (Cooperation agreement)	1		X								
C (Action plan)	1		X								
D (Review cooperation agreement and action plan)	1			X							
E (2x Research paper)	5			X	X	X	X	X			
F (Calculation report)	5			X	X	X	X	X			
G (Measurement report)	7								X	X	X
H (Draft of the final design report)	1										
I (Draft of the poster presentation)	1										
J (Final design report)	3										
K (Demonstration of the complete system)	1										
L (Poster presentation)	1										

Table 7: Activity schedule (continued)

Activity (code)	Time (in weeks)	BLOK4									
Week #		1	2	3	4	5	6	7	8	9	10
A (Kick-off project)	1										
B (Cooperation agreement)	1										
C (Action plan)	1										
D (Review cooperation agreement and action plan)	1										
E (2x Research paper)	5										
F (Calculation report)	5										
G (Measurement report)	7	X	X	X							
H (Draft of the final design report)	1			X							
I (Draft of the poster presentation)	1				X						
J (Final design report)	3			X	X	X					
K (Demonstration of the complete system)	1						-	-	-	-	-
L (Poster presentation)	1						-	-	-	-	-

9 Costs and benefits

There are costs that must be taken into consideration for carrying out the final project (PRO-Q2) of the first two years of the Electrical Engineering course at The Hague University of Applied Sciences. There are also benefits for carrying out PRO-Q2. The costs and benefits ultimately decide whether the project should be carried out or not. If the costs are higher then the benefits, then a decision must be made between abandoning the project or making changes in the project regarding the materials, location etc. The costs and benefits are therefore crucial for the project.

The costs for the project “PRO-Q2” are:

- The amount of time that each project member worked. Each project member must work at least 224 hours on the project.
- The necessary components and tools for building the preamplifier, power amplifier and the DCU.
- The power supply.
- The travel expenses. Project members have to travel by train, car, bus or bike to reach their workplace.
- The workplace which is The Hague University of Applied Sciences established in Delft.
- Necessary knowledge for carrying out the project PRO-Q2.

The benefits for the project “PRO-Q2” are:

- ETCS. The reward for succesfully clearing project PRO-Q2 is 8 ETCS.
- Research papers.
- Calculation reports.
- Measurements reports.
- Draft of the poster presentation.
- Final design report.
- A fully functional and active loudspeaker.

10 Risks analysis

During this project there are several risk factors that need to be taken into account. These factors can be divided into two subgroups: internal and external risk factors.

Examples of internal risk factors are:

- Insufficient Leadership: Not everyone is a born leader. In our group the project leader is choosen based on inexperience rather than experience, because the educational value is more important to us than having the best leader in this position.
- Inexperience: The project members are inexperienced and therefore they might not be up to the task.
- Language barrier: This project's working language is English and therefore all documentation and research papers are written in English. Spelling and grammar mistakes might occur and cause communication errors.
- Lack of motivation: Not all project members share the same interests. If a project member does not enjoy working on his assigned tasks, he might lose interest and become demotivated.
- Scope creep: When new features and ideas are added along the way the project might become too big to handle.

Examples of external risk factors are:

- Vague project goals: When the client's vision is not clear it is impossible to meet expectations.
- Transport failure: When public transit fails the project members will not be able to attend meetings or work sessions.
- Supply chain latency: When suppliers are unable to ship in time or at all prototyping can come to a hold.
- Change of business case: When the client's business case changes, the project goals have to be reassessed.

The effect of each risk is calculated in table 8.

Table 8: Risk effect calculation

Nr.	Risk	Probability	Severity	Effect
1	Insufficient leadership	3	8	24
2	Inexperience	7	5	35
3	Language barrier	1	8	8
4	Lack of motivation	2	6	12
5	Scope creep	2	7	14
6	Vague project goals	1	8	8
7	Transport failure	7	3	21
8	Supply chain latency	5	9	45
9	Change of business case	1	10	10

The risks are placed in a risk assessment matrix.

Risk Assessment Matrix				
Probability/ severity	Catastropic (1)	Critical(2)	Marginal (3)	Negligible (4)
Frequent (A)				
Probable (B)			Risk nr. 2 and 7	
Occasional (C)				
Remote (D)	Risk nr. 8			
Improbable (F)	Risk nr. 1	Risk nr. 4 and 5		
Eliminated (F)	Risk nr. 3,6 and 9			