



Neural-Control Exoskeleton

- Rebuild the relationship between human & machine

CS4457 – Project Management

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Table of contents

1. Introduction.....	1
1.1 Our Project.....	1
1.2 Why is Project necessary?	1
1.3 What is the Goal of our Project?	1
1.4 Success Criteria.....	2
2. Scope.....	3
2.1 Project Requirements	3
2.2 Requirements List	4
2.3 Scope Statement	5
2.3.1 Scope Description	5
2.3.2 User Acceptance Criteria.....	5
2.3.3 Deliverable	5
2.3.4 Out of Scope	5
2.4 WBS (For the Whole Process)	6
2.4.1 WBS Dictionary	7
2.5 Scope Creep.....	9
2.6 Scope Validation	9
3. Schedule	10
3.1 Planning the Schedule.....	10
3.2 Milestone List	11
3.3 Activity List	11
3.4 Critical Path	16
3.5 Schedule Tracking.....	17
3.6 Schedule Estimates.....	17
3.7 Gantt Chart.....	18
4. Cost	19
4.1 Meta-Info.....	19
4.2 Cost Identify	20
4.3 Cost Tracking.....	20
4.3.1 Criteria	20
4.3.2 Recording Cycle.....	20
4.3.3 Judgement	20
4.3.4 Notes	21
4.4 External Procurement	21
4.4.1 Resource Purchase.....	21
4.4.2 Outsource Work	22
4.5 Estimation (by Bottom-up with Work Packages).....	22
4.5.1 Work Packages	22
4.5.2 RBS	23

4.5.3 Overall Cost List.....	24
5. Quality.....	26
5.1 Quality Targets.....	26
5.1.1 Project Monitoring and Control.....	26
5.1.2 Project Planning	26
5.1.3 Load Capacity.....	26
5.1.4 Ability of Balance.....	26
5.1.5 No Environmental Impact	27
5.1.6 Process and Product Quality Assurance.....	27
5.2 Defect Detection	27
5.2.1 Pressure Resistance Detection.....	27
5.2.2 Balance Detection	27
5.2.3 Environment Detection	27
6. Stakeholders	28
6.1 Introduction.....	28
6.2 Stakeholder engagement plan.....	28
6.3 Stakeholder register	29
7. Communications.....	30
7.1Introduction	30
7.2Communication Management Plan	30
7.3 Concerns	31
8. Risk.....	32
8.1 Purpose	32
8.2 Risk Identify	32
8.2.1 SWOT	32
8.3 Risk Analysis	33
8.3.1 Guidance.....	33
8.3.1.1 Risk Level	33
8.3.2 Qualitative risk analysis.....	33
8.3.2.1 Probability-Impact analysis.....	33
8.4 Risk Analysis	34
8.5 Risks Response	37
8.5.1 SWOT	37
8.5.2 Detailed Response.....	37
8.6 Risk Monitor	38

1. Introduction

1.1 Our Project

The purpose of our project **Neural-Control Exoskeleton (NCX)** is to design and develop neural control exoskeleton, which aims to help people with disabilities recover to normal life and assist human beings in many fields, including medical treatment, industry, and military. It will provide more convenience for human life and development in the future, and there will be great development space in the future.

1.2 Why is Project necessary?

- There are 140 million people with physical disabilities in the world. exoskeleton help patients who have lost their leg function to assist walk, help people with stroke and spinal cord injury to achieve walking ability. They need other equipment to complete basic life behaviors.
- It can improve the accuracy of doctors' surgery and help nurses carry critically ill patients.
- The continuous development of the social economy needs to improve production efficiency.
- Soldiers will consume a lot of physical energy and be easily hurt by shrapnel when they fight. Exoskeleton helps soldiers walk to reduce fatigue, easily navigate through difficult terrain. Increase the ability of soldiers to carry weight, enable soldiers to use heavy firearms, resisting the damage from the outside, such as the shrapnel of the shell and reduce soldier reaction time.
- Helping workers carry heavy loads in the industry. Avoiding injury to workers' shoulders and spine and reduce worker fatigue.

1.3 What is the Goal of our Project?

The purpose of our project is to make neuro control exoskeleton widely used in the medical operation, military operation, security, fire protection, industrial production, and other fields, and to sell neuro control exoskeleton to the world (China, the United States, the United Kingdom, Ireland, Japan, etc.). And actively strengthen the management of natural control exoskeleton in relevant fields, obtain further economic support from the government and the state, and further improve the function of the exoskeleton.

1.4 Success Criteria

We must meet the following requirements for the success of our project

- Successfully designed and developed the first batch of NCX in about 6 months
- Put NCX into the market in the form of preliminary finished products and get people's positive feedback
- Sell NCX to the defense forces and armed police forces for their financial support and government policy support
- Plan to continuously improve and develop NCX in the future and expand its sales to countries all over the world

Successfully designed and developed the first batch of NCX in about 6 months

Considering our competitors, the same enterprises engaged in exoskeleton research and development (b-temia, bionic power, rewalk robotics, etc.) may lead in the development of a new generation of powered exoskeleton devices, we will intensify the research and development of new products, and strive to develop the first product of the first generation within six months.

Put NCX into the market in the form of preliminary finished products and get people's positive feedback

After the new NCX is developed, it will be put into use in the industrial production first, and track the user's feedback for six months in a row, and finally get the user's positive feedback.

Sell NCX to the defense forces and armed police forces for their financial support and government policy support

After getting good user feedback, it can enter the stage of mass production, obtain economic support from the defense forces and the government, and encourage policies, and develop products suitable for a wider range of fields, such as medical, police and fire control NCX.

Plan to continuously improve and develop NCX in the future and expand its sales to countries all over the world

It is planned to have funds to continuously improve the dynamic exoskeleton in the future and sell it to countries around the world, including Asia, North America, and Europe, and establish R&D bases in major cities, and cooperate with local departments to strengthen the worldwide dynamic exoskeleton control policies.

2. Scope

2.1 Project Requirements

- **For the general disabled, or the elderly with muscle weakness :**

we will provide the lower price (about 10000 Euro) exoskeleton device with the function of helping to complete the basic life behavior.

- **For workers, firefighters and nurses:**

We will provide exoskeletons with the function of enhancing load-bearing capacity and relieving muscle fatigue and the price is relatively low (about 10000 Euro) , which will facilitate workers to move heavy objects, firefighters to carry heavier fire-fighting equipment and wounded, and help nurses to carry patients.

- **For military and police exoskeletons:**

Exoskeleton for better protection, it needs to be able to improve the load-bearing capacity, help soldiers transport the wounded, improve the ability of soldiers to carry heavy weapons, reduce the consumption of soldiers in movement, and provide some trunk protection functions.

2.2 Requirements List

As a relatively advanced technology and equipment, it should have excellent performance in both medical and military fields. Here are a few points that will be taken as the capabilities of exoskeleton.

Requirement ID (REQ. #)	Requirement Text	Category	Priority
1	When the patient's motor nerve reflex, the device should acutely capture the reflex and assist the patient to complete the action.	Functional	HIGH
2	NCX should depend on the electric signal to assist people to complete the action	Functional	HIGH
3	NCX is equipped with emergency braking system and can be braked manually	Functional	HIGH
4	The NCX should be light and flexible	Non-Functional	MEDIUM
5	Hydrogen battery with stable output power is needed for continuous power supply	Functional	MEDIUM
6	NCX should increase user comfort and be ergonomic	Non-Functional	MEDIUM
7	NCX must have air muscle similar to hydraulic device to complete user's movements.	Functional	MEDIUM
8	NCX should be designed according to the size of users	Non-Functional	MEDIUM
9	NCX should be foldable, easy to carry	Non-Functional	LOW

2.3 Scope Statement

2.3.1 Scope Description

This project is to design and develop an NCX (neural control exoskeleton) to enhance the human body's mobility. The dynamic skeleton will rely on the non-implanted BCI to capture the role of the user's motor nerve. After the captured information is processed in the processing chip, the motion control system will control the air muscle hydraulic device, so as to help the user to assist in movement.

The project will be carried out in many fields to help patients with physical disabilities move, improve the accuracy of medical operations, improve the survival rate of soldiers on the battlefield, and improve industrial production efficiency.

2.3.2 User Acceptance Criteria

The project can be sponsored and supported by many enterprises and government and military. It can improve the quality of human life and production efficiency in many aspects and is widely recognized by society and countries.

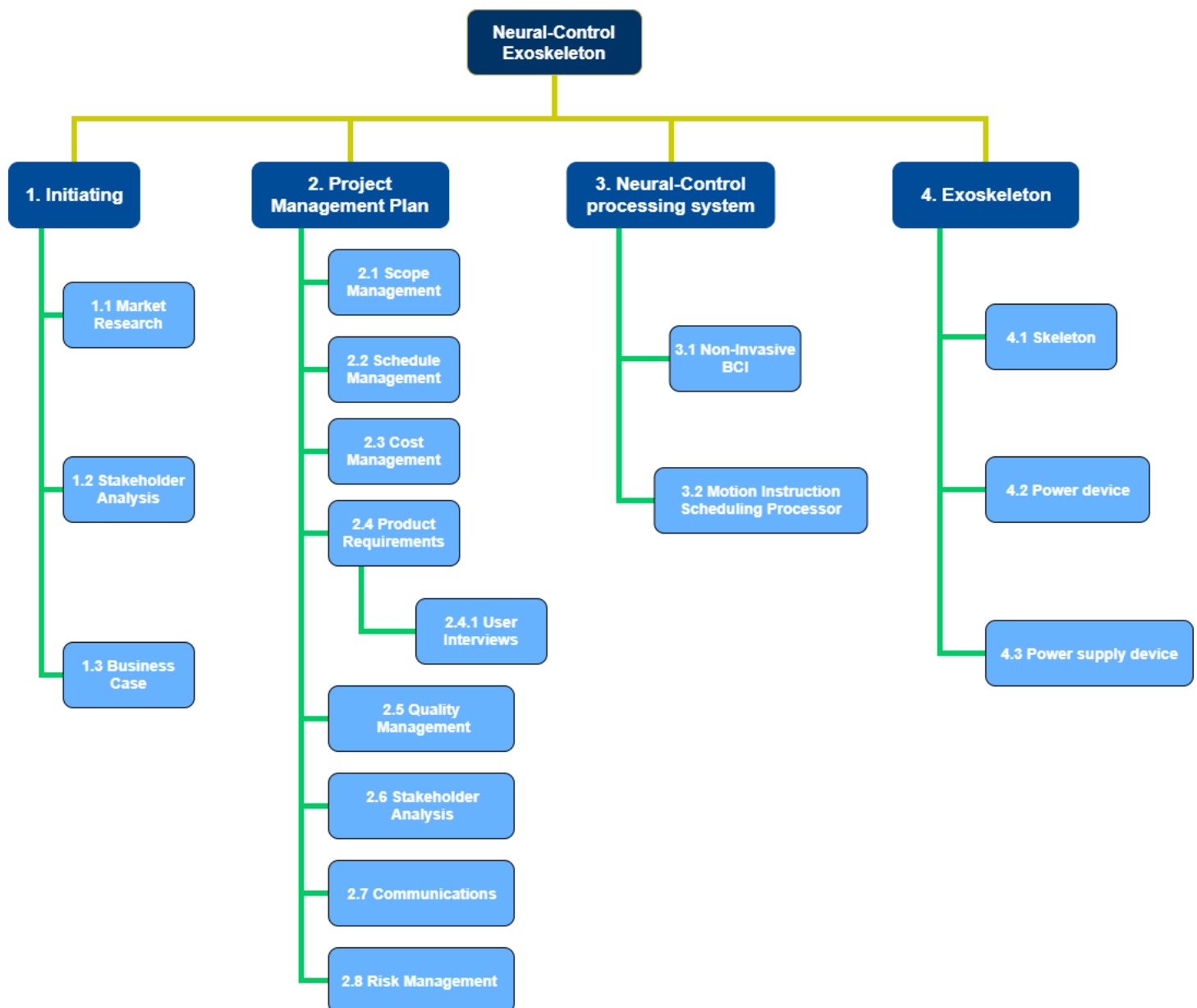
2.3.3 Deliverable

- NCX have a sensitive BCI device capable of capturing users' motor responses.
- NCX have a motion processing chip responsible for receiving and processing motion instructions.
- NCX must have air muscle similar to hydraulic device to complete user's movements.
- Hydrogen battery with stable output power is needed for continuous power supply.
- NCX would be designed according to the size of users.

2.3.4 Out of Scope

- The NCX will not be remotely controlled.
- NCX does not have the ability to deal with actions independently, and can only rely on human motion signals.
- When NCX is used as a walking aid for patients, it does not have the effect of enhancing the carrying capacity.
- NCX does not have the effect of enhancing body bulletproof when used in industrial production and civil use.

2.4 WBS (For the Whole Process)



2.4.1 WBS Dictionary

WBS Number	Title	Responsible Person	Description
1	Project Manager	Project Manager	Preliminary activities required for defining project goals, requirements and gaining project approval.
1.1	Market Research	Project Manager	Activities involving gather data from customers and investigating existing products to find the market niche this project is attempting to fill.
1.2	Stakeholder Analysis	Project Manager	Activities involving determining and managing stakeholders.
1.3	Business Case	Project Manager	Defining the problem the project will solve and detailing how the project will generate revenue. The Project Charter will be a key deliverable of this work package, which stakeholders will need to sign-off on to approve the project.
2	Project Management Plan	Project Manager	The project management plan contains details of all activities involved in the project as well as how to execute, monitor and control the project
2.1	Scope Management	Project Manager	Scope management defines all the work involved in the successful completion of this project.
2.2	Schedule Management	Project Manager	This document defines all the activities required to complete this project, as well as estimates to the time and resources required.
2.3	Cost Management	Project Manager	Identify the costs associated with the project, Explain the idea of external procurement and how we would decide to outsource work or purchase equipment and materials.
2.4	Product Requirements	Project Manager	Definition of requirements for the hardware and software components being delivered as part of this project.
2.4.1	User Interviews	Project Manager	Interview key stakeholders to elicit the projects requirements. This will primarily involve interviewing user as they will be the primary users of the NCX.
2.5	Quality Management	Project Manager	Our plan to take to ensure the project deliverables are bug-free.
2.6	Stakeholder Analysis	Project Manager	We would determine our stakeholders,
2.7	Communications	Project Manager	To communicate with our stakeholders, and concerns we need to address here.
2.8	Risk Management	Project Manager	Detailed analysis of threats and opportunities that may affect this project.
3	Neural-Control processing system	Technical Lead	Neural control processing system refers to the system that obtains the information of human motor nerve, and processes and transforms the neural signal into electrical signal.
3.1	Non-Invasive BCI	BCI R&D Administrator	BCI will acquire neural signals from the motor nerve center and convert them into electrical signals.
3.2	Motion Instruction Scheduling	Technical Lead	Translate signal processing from the BCI receiver into mechanical instructions.

	Processor		
4	Exoskeleton	Technical Lead	Combination of main mechanical parts to perform movement.
4.1	Skeleton	Technical Lead	Framework made of new alloy.
4.2	Power device	Technical Lead	Provide power for NCX movement.
4.3	Power supply device	Technical Lead	Provide energy supply for movement.

2.5 Scope Creep

At present, the internal combustion engine power supply used in the power plant can improve the energy output, and the problem of heat dissipation will be a difficulty for us. Therefore, the portable battery needs to be replaced frequently, otherwise it may cause explosion due to thermal runaway. However, the hydrogen battery has the problem that the exhaust gas emission and heat cannot be regulated stably.

We plan to use the nichrome hydrogen battery as the power take-off device. The battery is stable in nature and has been used in hybrid vehicles at present. However, the charging speed of the NiMH battery is very slow, and it will take about 1 day to fully charge, so it needs to replace and charge multiple batteries in turn.

2.6 Scope Validation

- At present, the research of exoskeleton is continuing and the basic technology is improving. Although the control accuracy of noninvasive BCI is not as good as invasive BCI for the time being, the emergence of noninvasive BCI makes the combination of human and computer more flexible and acceptable.
- Neural decoding has become possible, which will be a breakthrough to improve the accuracy of exoskeleton operation. At the same time, machine learning can help users and machines after a period of running in, better collaboration.
- Magnesium alloy has the advantages of high strength low density and low price.
- Exoskeleton equipment will comply with the laws of medical devices and outdoor equipment and will be adjusted according to the laws of different countries.

3. Schedule

3.1 Planning the Schedule

For this project, we have enough time to research, design and manufacture, because no company on the market can manufacture exoskeleton that ordinary people can afford. Our project will take a total of 104 weeks, which is about two years.

The initial stage of the project is the most difficult. We have no funds and need to raise funds, so we need to make a satisfactory exoskeleton first. To make a good production, we need to design our exoskeleton, including its appearance, materials, operation methods, cost, and so on. Because we already have a preliminary design idea, this is not difficult, it will take us about 20 weeks.

Once we have the design, we will start to create sets of beta-exoskeleton. At this stage, we will spend 84 weeks, accounting for more than half of the total plan. These sets of the exoskeletons are for showing to everyone and are used to raise funds, so we only need to make several sets. It takes about 12 weeks to make beta-exoskeletons, we will make them as soon as possible, and then start to promote. After producing, we will start crowdfunding. This will be our first source of funds. Crowdfunding will last for 12 weeks. When the crowdfunding is over, we will start to make the first batch of the exoskeleton, which will take about 24 weeks to produce 5000 sets of exoskeleton. Finally, we will sell the exoskeleton produced to those involved in crowdfunding and collect their feedback. With sufficient funding, we will proceed to the second stage, mass production of exoskeleton and sale. After collecting feedback from crowd funders, we will make changes to the exoskeleton, which will take 2 weeks. After that, production and sales to various countries and regions, we produce 5000 sets of exoskeleton in each production cycle, and one cycle takes 24 weeks

During the production of crowdfunded exoskeletons, we will train professional exoskeleton service staff who will help users around the world when exoskeleton production is completed, teach them how to use them, and help them repair exoskeleton. It will take 4 weeks and it ends at the same time as production.

Finally, we will sell our exoskeleton to the military, which is a long process, so there is no time limit. In the meantime, we strive to get their financial support. After getting enough funds, we will make better exoskeleton.

3.2 Milestone List

Milestone No.	Milestone name	Work Package	Estimated Completion
1	Shape design complete	1.1	26/01/2020
2	Core design complete	1.2	19/04/2020
3	Beta-produce	2.1	12/07/2020
4	Crowdfunded production	2.4	02/05/2021
5	Train exoskeleton instructors	3.1	02/05/2021
6	Mass production	2.7	28/11/2021
7	Receive the military support	4.2	-

3.3 Activity List

3.3.1 Activity List (WBS View)

(M)-Milestone

Neural-Control Exoskeleton

1. Design

1.1 Shape design. **(M)**

1.2 Core design. **(M)**

2. Production

2.1 **Phase1:** Create sets of beta-produce. **(M)**

2.2 Test the exoskeleton.

2.3 Launch the crowdfunding.

2.4 **Phase2:** Produce 5,000 exoskeletons. **(M)**

2.5 Collect market feedback.

2.6 Change the exoskeleton and market strategy.

2.7 **Phase3:** Produce 5,000 exoskeletons. **(M)**

3. Service

3.1 Train some professional exoskeleton instructors. **(M)**

4. Become Better

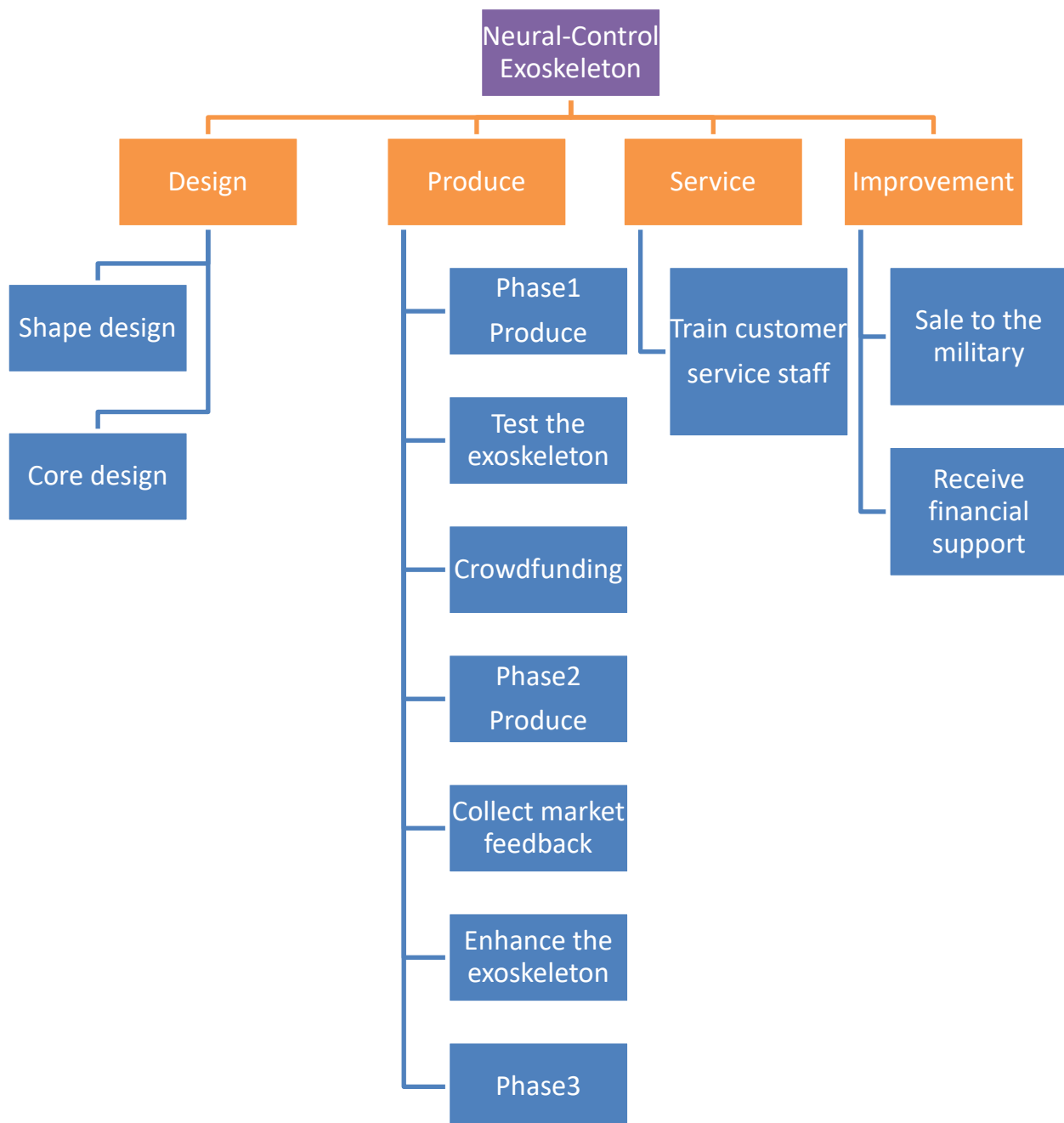
4.1 Sale the exoskeleton to the military.

4.2 Receive their financial support. **(M)**

3.3.2 Activity List (Attributes View)

Activity List				
Project: Neural-Control Exoskeleton			Date: 29/11/2019	
Activity ID No.	Activity Name	Description of Work	Start Date	Finish Date
1.0	Design	This activity consists of ensuring that we can design a set of exoskeleton.	01/12/2019	19/04/2020
2.0	Production	This activity consists of ensuring that we will sell our products to every countries.	19/04/2020	28/11/2021
3.0	Service	This activity consists of ensuring that users can get good service.	04/04/2021	02/05/.2021
4.0	Become Better	This activity consists of ensuring that we can product better exoskeletons.	05/09/2021	-

3.3.3 WBS (For Involved Activities in Project)



WBS No: 1.1	Predecessors: None	Successors: 1.2
Activity: Shape design.	Description: Designing the appearance of exoskeleton.	
Constraints: Budget	Resources: Professional designer.	

WBS No: 1.2	Predecessors: 1.1	Successors: 2.1
Activity: Core design.	Description: Design the function and structure of the exoskeleton.	
Constraints: Budget	Resources: Professional mechanical engineer.	

WBS No: 2.1	Predecessors: 1.2	Successors: 2.2
Activity: Phase1: Create sets of beta-produce.	Description: Produce some exoskeleton and show it to everyone.	
Constraints: None	Resources: Exoskeleton manufacturing plant.	

WBS No: 2.2	Predecessors: 2.1	Successors: 2.3
Activity: Test the exoskeleton.	Description: Test for exoskeleton eligibility.	
Constraints: None	Resources: People who can use exoskeleton.	

WBS No: 2.3	Predecessors: 2.2	Successors: 2.4
Activity: Launch the crowdfunding.	Description: To raise funds.	
Constraints: None	Resources: Reliable crowdfunding website.	

WBS No: 2.4	Predecessors: 2.3	Successors: 2.5
Activity: Phase2: Produce 5,000 exoskeletons.	Description: Produce exoskeleton to crowdfunders.	
Constraints: None	Resources: Exoskeleton manufacturing plant.	

WBS No: 2.5	Predecessors: 2.4	Successors: 2.6
Activity: Collect market feedback.	Description: Initiate an email consultation with crowdfunders and get their feedback	
Constraints: None	Resources: People who organize feedback.	

WBS No: 2.6	Predecessors: 2.5	Successors: 2.7
Activity: Enhance the exoskeleton and market strategy.	Description: Improve our products.	
Constraints: Budget	Resources: Designer and engineer.	

WBS No: 2.7	Predecessors: 2.6	Successors: 2.8
Activity: Phase3: Produce 5,000 exoskeletons.	Description: Mass production of exoskeleton.	
Constraints: None	Resources: Exoskeleton manufacturing plant.	

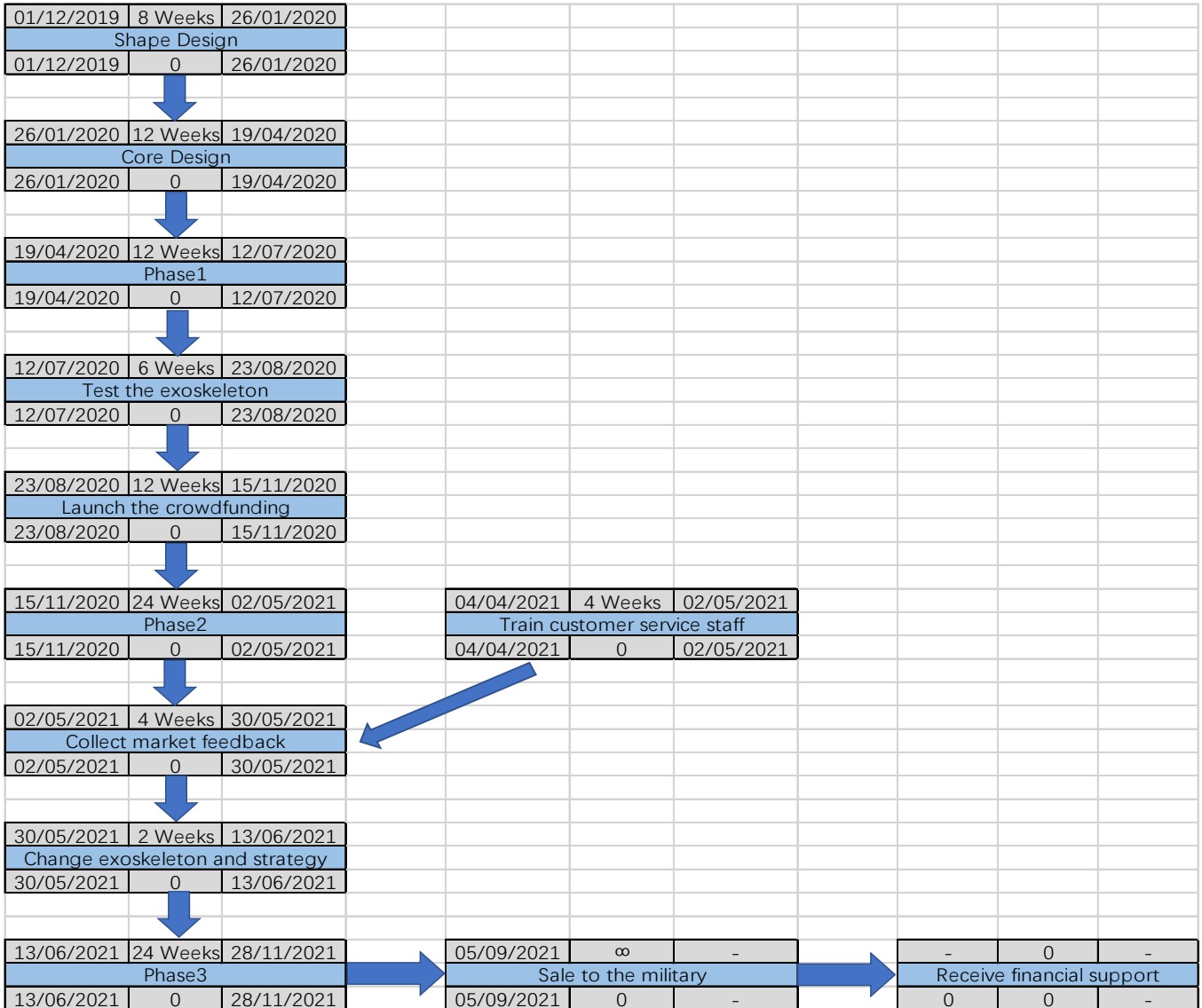
WBS No: 3.1	Predecessors: None	Successors: None
Activity: Train some professional exoskeleton instructors.	Description: Training professionals who can help buyers use exoskeleton.	
Constraints: None	Resources: Teachers who can use exoskeleton.	

WBS No: 4.1	Predecessors: None	Successors: None
Activity: Sale the exoskeleton to the military.	Description: Sell to the military for more money.	
Constraints: None	Resources: Exoskeleton can help normal people improve their physical capabilities	

WBS No: 4.2	Predecessors: None	Successors: None
Activity: Receive their financial support.	Description: Get more funding support.	
Constraints: None	Resources: Professional sales staff.	

3.4 Critical Path

Early Start	Duration	Early Finish
Activity Name		
Late Start	Float	Late Finish



3.5 Schedule Tracking

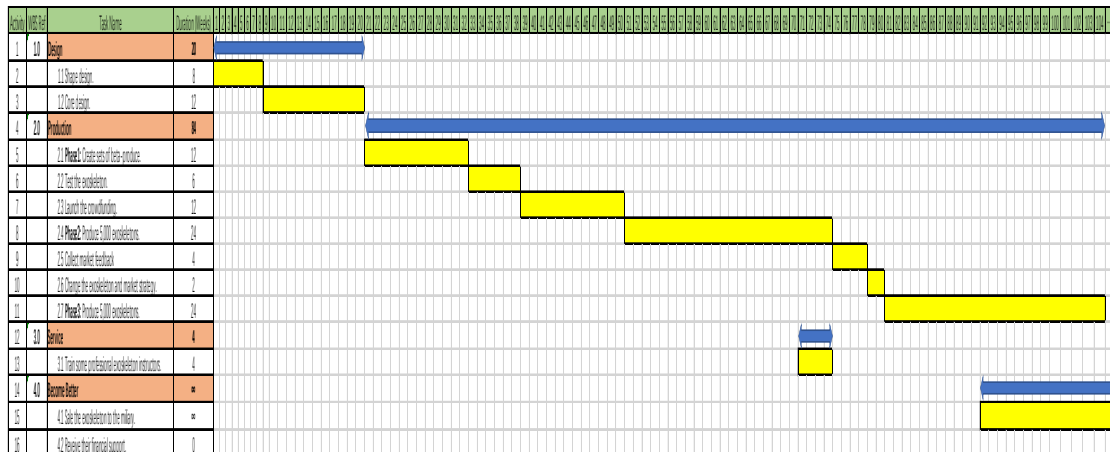
For the purposes of ensuring the project fits the schedule, we will tell all employees about the time schedule. We will also hire the most professional talents in the relevant fields to ensure that they are completed with high quality within the planned time. Ideally, our projects for each phase will be completed about a week before the scheduled time. Even if we encounter any difficulties or unexpected situations in actual manufacturing, we can guarantee that it will be completed within the planned time. The project is divided into four phases, design, production, service and become better. The first stage is design, we do not need many people. We only need some designers and engineers, so the time in this stage is well controlled. We can speed up the progress and leave more time for subsequent manufacturing and testing. The second stage requires more people, and there are uncertain factors in manufacturing and testing. If we can complete the previous stage in advance, this stage will have more time to deal with unexpected situations. This also requires our employees to have good resilience, which is why we choose professionals.

3.6 Schedule Estimates

Since the project was completed within two years and there were not many steps in the division, we think that the weekly estimate is more appropriate. Although there are some tasks that do not take the last full week, we calculate them based on one week. On the one hand, we have left some extra time for each stage to deal with sudden troubles. On the other hand, we can advance to the next stage in advance, leaving time from simple tasks to difficult tasks.

Estimates are assigned based on the difficulty and uncontrollability of the tasks at each stage. We will ask the relevant personnel at each stage about their minimum use time, and then increase the time based on uncontrollability. For example, the time of the first stage is easier to control, so it is planned according to the time given by the designer and engineer; while the second stage is more uncontrollable, so we have set aside two weeks.

3.7 Gantt Chart



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4. Cost

Purpose

The purpose of cost management is to determine the cost needed in a project to help develop appropriate financial estimates

In NCX project, cost is mainly related to building manufacturing and research and development. This part will analyse the types and estimates of various costs, and will also analyse how to track the cost during the project

4.1 Meta-Info

Cost Management Plan	
Units of Measure	Staff (Hours), Material (Kg), Date (week = 8hours * 5days)
Level of Accuracy	± 10% for realistic cost estimates is allowed (include±3% for Management reserve, ±3% for Contingency reserve & ±4% for Activity reserve).
Procedure Links	WBS & Ghannt
Rules of Performance Measurement	Cost Variance (Earned Value – Actual Cost).
Reporting Formats	Reporting are reported by project manager monthly.
Strategic Funding Choices	Starting fund is needed and part of phase 1 & 2 will be collected by crowd-funding, but adopt investor fund would not be excluded.

4.2 Cost Identify

Entity	Type
Workplace	sunk
Workshop (Rent)	sunk
Desktop PC	sunk
Technology Research	sunk
Labour	variable/direct
Material	variable/direct
Maintenance	variable/indirect

4.3 Cost Tracking

4.3.1 Criteria

Gantt and JIRA could be helpful to keep track of costs. Project cycle and consumption would be managed and controlled through using CPI and SPI. At the same time, using cost variance in a correct way. Monitoring project cost variance is critical to ensuring the project is delivered on budget.

4.3.2 Recording Cycle

Record the cost of HR, equipment, materials and maintenance and purchase. The record cycle of labour salary is 28 days, and the rest records should be recorded in time after the cost is generated.

4.3.3 Judgement

Meanwhile, a judgment mechanism should be introduced. When the gap between the current funding consumption and the expected consumption is $\pm 10\%$, the current progress should be marked with yellow warning and reported. If it is determined that there is no or little impact on baseline, other remedy methods may not need. When the gap is $\pm 20\%$, the progress should be marked with red warning. At this time, the project manager and his management team should immediately analyse the risk, and make adjustment and correction within the risk tolerance rang.

4.3.4 Notes

a) Labour Costs

The record cycle of Labour costs is 28 days. Every 28 days, employee wages and bonuses should be recorded. Random sampling should be carried out on the records to ensure the accuracy of the data.

b) Equipment Costs

Equipment consumption mainly refers to the time before the phase2 batch production, the technical team needs to produce a certain amount of beta version, including the purchase, maintenance, update and test consumption after the initial production of the NCX equipment.

c) Material Costs

The material consumption runs through the whole production process. The materials used in the outsourcer's site from design, production beta version, and outsourcing process all belong to this range. The records of material consumption should be accurate and timely.

4.4 External Procurement

4.4.1 Resource Purchase

Item	Source	Unit Price
Magnesium Alloy (We43)	Hilbo	€ 25/kg
Workbench Kit	Mason Technology	€ 500
Desktop PC	DELL	€ 700

4.4.2 Outsource Work

Machine manufacturing factories and workshops cost a lot of money and time. Therefore, in this project, we will rent the manufacturing workshops of famous companies in the industry because of the blueprint and precision design of the project, and we still need our own technical personnel for production and assembly in manufacturing. There have been many cases of internal and external communication errors in the industry, resulting in a large number of losses, moreover, NCX will concern about user safety, so it is the most reasonable way to rent only the production workshops of other companies.

4.5 Estimation (by Bottom-up with Work Packages)

4.5.1 Work Packages

WP_1 - Shape Design - 8wks
Schematic artists*6, Ergonomic instructor*1, Desktop PC*6, Workbenches*6.

WP_2 - Core Design - 12wks
Technical expert*1, Schematic artists*6, Engineers*12, Desktop PC*15, Workbenches*15.

WP_3 - Phase 1 production - 12wks (create sets of beta-produce)
Schematic artists*6, Ergonomic instructor*1, Desktop PC*6, Workbenches*6.

WP_4 - Testing - 6wks
Engineers * 12, System testers * 2, Schematic artists*6, Safety testers * 2

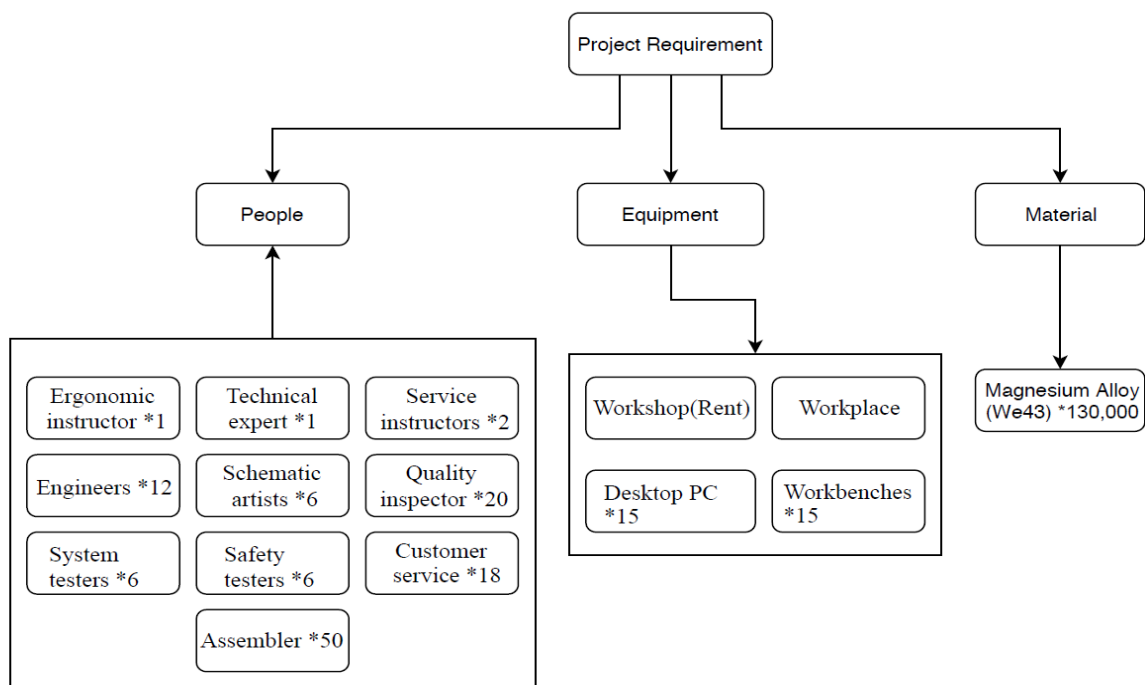
WP_5 - Phase 2 production - 24wks (Assembly line production and assembly in the rented factory)
Workplace rent * 24w, Engineers * 12, Schematic artists*6, System testers * 6, Safety testers * 6, Quality inspector * 20, Assembler * 50

WP_6 – Collect feedback & improvement - 6wks
Engineers * 12, Schematic artists*6, System testers * 6, Safety testers * 6

WP_7 - Phase 3 production - 24wks
Workplace rent * 24w, Engineers * 12, Schematic artists*6, System testers * 6, Safety testers * 6, Quality inspector * 20, Assembler * 50

WP_8 - Customer service train - 4wks
Instructors * 2, Customer service * 18

4.5.2 RBS



4.5.3 Overall Cost List

Personnel	Daily Salary (€) (hour rate * 8)	Days	Quantity	Salary(€)
*Ergonomic instructor	320 (40 * 8)	8wks * 7	1	17,920
*Technical expert	320 (40 * 8)	12wks * 7	1	26,880
Schematic artists	200 (25 * 8)	92wks * 7	6	772,800
Engineers	200 (25 * 8)	92wks * 7	12	1,545,600
System testers	176 (22 * 8)	92wks * 7	6	680,064
Safety testers	176 (22 * 8)	92wks * 7	6	680,064
Quality inspector	144 (18 * 8)	48wks * 7	20	967,680
Assembler	144 (18 * 8)	48wks * 7	50	2,419,200
*Service instructors	200 (25 * 8)	4wks * 7	2	11,200
Customer service	144 (18 * 8)	48wks * 7	18	870,912
Overall	7,992,320			

Equipment	Unit Price	Quantity	Spend (€)
Workbench kit	€500	15	7,500
Desktop PC	€700	15	10,500
Workplace	450,000(650m ²)	1	450,000
Workshop (Rent)	€2000/wk(3000m ²)	48	96,000
Maintenance	5% of all above		28,200
Overall	592,200		

Material	Unit Price	Quantity	Spend (€)
Magnesium Alloy (We43)	€25/kg	10010suits * 25	6,256,250

Entity	Spend(€)
Technology Research	1,000,000

Data Source: www.thejournal.ie , www.jobs.ie & <https://www.daft.ie/>

The personnel marked with “*” are external employees, who would be paid according to the actual working days. Others would be paid according to the contract days.

4.6 Budget

Cost	Spend (€)
Labour	7,992,320
Equipment	592,200
Material	6,256,250
Technology	1,000,000
Reserve	10%
Overall	17,425,000.0

The Overall Budget: **17,425,000.0€**

5. Quality

Exoskeleton needs to be used by disabled people, so quality is very important, we won't be lax in this regard.

5.1 Quality Targets

The following points are our goals for the quality of exoskeleton produced.

5.1.1 Project Monitoring and Control

The purpose of project monitoring and control is to clearly understand the current progress of the project and to allocate work more reasonably based on the remaining time. If the project progress exceeds expectations, we will consider whether to slow down production or move on to the next stage in advance. If the current progress is slower than the estimated progress, we will decide whether to speed up the production or extend the production period.

5.1.2 Project Planning

The activities involved in project planning include:

- Developing a project plan
- Communicating with stakeholders
- Getting support for the project
- Make a commitment to the public
- Implementation the plan

Project planning enables accurate cost and schedule estimates and predictable output of project activities.

5.1.3 Load Capacity

Our exoskeleton can help people who have lost their legs to stand up, so it needs to be strong enough to withstand 250kg. The product will not be damaged when users use exoskeleton to carry heavy objects.

5.1.4 Ability of Balance

One of biggest difficulties with exoskeleton is that users cannot keep machine legs well balanced. Our goal is to make it easy for users to walk, squat and bend down.

5.1.5 No Environmental Impact

Our exoskeleton will sell all over the world, some places are hot, some are cold, and some are humid. Our products need to be able to withstand a high temperature of 200 degrees Celsius, a low temperature of -100 degrees Celsius, and they will not rust.

5.1.6 Process and Product Quality Assurance

In order to ensure the craftsmanship and quality of our exoskeleton, we invite three well-known designers and several assistants to discuss and design together. The design content involves appearance, materials, functions, manufacturing processes, etc. The purpose is to design a set of Practical and beautiful exoskeleton. In the production stage, we use the most advanced machines for production and invest a lot of manpower to carry out product inspections in order to improve the qualification rate of product. When training professional sales staff, we will require them to strictly check for damage every time they sell the product to ensure that customers buy the highest quality exoskeleton.

5.2 Defect Detection

In order to make the exoskeleton we sell have no quality problems; we select 30 out of every 100 exoskeletons produced for the following quality inspections.

5.2.1 Pressure Resistance Detection

We will apply 280kg of pressure to each selected test exoskeleton to ensure that they can indeed support 250kg in normal times.

5.2.2 Balance Detection

Testers will put on the exoskeleton and perform walking, squatting and bending tests on the uneven roads.

5.2.3 Environment Detection

Place the exoskeleton in a high temperature of 200 degrees Celsius for 20 minutes, a low temperature of -100 degrees Celsius for 20 minutes, and soak it in water for a while, then place it in the air for two days to observe whether it is rusty.

6. Stakeholders

6.1 introduction

In the process of identifying stakeholders, we referred to the contract, project charter, and conducted brainstorming sessions. This is critical to the success of the entire project. The information of stakeholders of this project is as follows.

High Power	<ul style="list-style-type: none">Medical Device Regulatory Agency	<ul style="list-style-type: none">Quartermaster
Low Power	-	<ul style="list-style-type: none">CustomerLocal hospital&&building development companyLocal Technology FoundationVolunteers
	Low Interest	High Interest

6.2 Stakeholder engagement plan

Name	power	Interest	Current engagement	Potential engagement strategies
Medical Device Regulatory Agency	High	Low	Neutral	We need to provide all changes about the product to the regulatory authority to confirm that the product complies with the law and successfully put it on the market for sale.
Local hospital&&building development company	Low	High	Supportive	We need to provide all changes for the product to them carefully consider their suggestions for the product, and improve the usability of the product.
Customers	Low	High	Unaware	Hold off engagement until later development.
Volunteer	Low	High	Supportive	Volunteers are recruited through Internet sites. We will actively contact volunteers to inform them of their participation in project testing activities.
Local Technology Foundation	Low	High	Supportive	The foundation is very supportive of the project and has low participation in the project.
Quartermaster	High	High	Supportive	We need to provide all changes for the product to them, liaise with military technicians to ensure product stability is sufficient for military use.

6.3 Stakeholder register

Stakeholder Register						
Identification			Importance		Expectations	Communication Strategy
#	Name	Role	Power	Interest		
1	Medical Device Regulatory Agency	Review whether the product's function meets the requirements of relevant laws and decide whether the product is allowed to be put on the market	High	Low	the product's function meets the requirements of relevant laws to make it be put on the market	Meeting
2	Local hospital & building development company	Interested in the expected functionality of the product, funding the project	Low	High	looking forward to the product's effective help for patients with disabilities & look forward to the product's safety guarantee for outdoor workers, improving work efficiency	Meeting
3	Customers	-	Low	High	Expect product features to facilitate the disabled	-
4	Volunteer	Volunteers help the R&D team to test the product and advise on product improvements	Low	High	Expect this product to help more people and promote technological progress	Face-to-face
5	Local Technology Foundation	Recognize the prospects of the project, and provide research and development funding for this technology product to support technology research	Low	High	Expect products to promote national scientific and technological progress and provide valuable references for future projects	Phone, Email
6	Quartermaster	Propose improvements to make the product stable for military use	High	High	Expect products to be purchased as stable military equipment	Meeting

7. Communications

7.1 Introduction

Through the register, we have established a communication plan to ensure that we get in touch with stakeholders in a timely manner, which will help us improve the usability of the product and meet the expectations of investors and product users.

7.2 Communication Management Plan

Stakeholders	Communications objective	Message	Channel(s)	Timing
Medical Device Regulatory Agency	Obtain a Product Sales License	Show project charter and finished products to regulatory authority	Meeting	1) Meeting at the beginning of the project cycle 2) After the finished product is produced
Local hospital & building development company	Get investment, make product functions as expected as possible and get product orders from them	Show product development progress and product changes	Meeting	Once a week
Quartermaster	Get investment, make product functions as expected as possible, provide higher stability and special design, get product orders from military	Show product development progress and product changes	Meeting	Once a week
Volunteer	Obtain product test data and suggestions from testers	Semi-finished and finished products	Face-to-face	When the product changes and needs to be re-evaluated
Local Technology Foundation	Obtain a reasonable amount of R & D funding	Show project charter	Phone, Email	Contact them at the beginning of the project cycle

7.3 Concerns

Security for testers (volunteers)

Due to the danger of the experiment, the test site needs to be provided with sufficient safety guarantee facilities to ensure the personal safety of the volunteers.

Unexpected problems

When there are unexpected problems after product changes, organizing face-to-face meetings will consume a lot of time. You need to organize video conferences through the applications of skype and zoom. Through various parties' discussions, we can efficiently solve the problem.

Find appropriate users

How to contact users who are willing to use NCX before phase1 is released.

Deal with Military order

How to contact the military and make the military trust our project to equip soldiers with NCX equipment.

8. Risk

8.1 Purpose

The purpose of risk management is to find out the possible risks in the process of the project and make corresponding strategies for them. In order to correctly analyse the risks, this section will adopt several technologies. Risk management could help the project team grasp the project progress better, reduce the risk and improve the success probability of the project

8.2 Risk Identify

In order to comprehensively analyse the risks of the project, we have carried out brainstorming and SWOT analysis. SWOT analysis includes the strengths and weaknesses, opportunities and threats of the project. These risks are based on Market, Financial, Technology, People and Structure/process.

8.2.1 SWOT

Strengths 1. Novel technology. NCX do not need to use invasive BCI, which will not cause injury to the body. 2. Novel and creative. Use machine to improve the living standard of the disabled will be greatly improved.	Weaknesses 1. High technical level requirements. 2. High financial level requirements. 3. Non-invasive BCI is not mature at present, and its control accuracy is not as good as that of invasive BCI.
Opportunities 1. Great Market demand. NCX has great attraction in industry, medical treatment and so on. 2. Military investment. In order to enhance national defence, the government and the army will invest in this project.	Threats 1. Experiment failure. Experiment failure leads to continuous extension of R & D cycle. 2. Test injury. There is danger during the test, which may cause injury to the tester. 3. Insufficient funds. Insufficient funds were raised in the crowdfunding process. 4. Be refuted. Strongly opposed and condemned by conservatism. 5. Misuse. May be used by terrorists. 6. Inadequate design. New materials and design may still be too heavy for children and the elderly

**Details and descriptions for risks will be showed in risk register.*

8.3 Risk Analysis

8.3.1 Guidance

8.3.1.1 Risk Level

- 1) Individual
 - a) T-1: schedule
 - b) T-2: schedule
 - c) T-3: budget, schedule
 - d) T-4: schedule
 - e) T-5: scope
 - f) T-6: market
- 2) Overall
 - a) O-1
 - b) O-2

8.3.1.2 Unknown Risks

The risk of the project is high, the requirement of science and technology is high, and the test and quality inspect are very important. Accidents may occur during the test, in order to deal with the unknown risk, 10% of the project cost should be prepared as the extra project budget.

8.3.2 Qualitative risk analysis

8.3.2.1 Probability-Impact analysis

High			O-1 O-2
Medium		T-1 T-3	
Low	T-4 T-5 T-6	T-2	Threat 1 Threat 2 Threat 6
Probability Impact	Low	Medium	High

*Overall Score: $0.72 * 2 - 0.1 * 2 - 0.06 - 0.03 * 3 = 1.09$

8.4 Risk Analysis

ID	O-1	O-2
Risk	Great Market Demand	Military Investment
Rank	1	2
Description	The project has huge demand in various industries in the market which stimulates the realisation of the project.	The government and the army invest in the project and provide sufficient funds and technical support for the project.
Probability	0.9	0.8
Impact	0.8	0.9
Category	Market	Structure
Root Cause	External	National Defence
Triggers	Market	NCX has strong individual ability
Owner	Marketing Strategy Department	Project Manager

ID	T-1	T-2	T-3
Risk	Experiment failure	Test injury	Insufficient funds
Rank	2	4	3
Description	The experiment failed to get the expected result and function.	An accident occurred during the test, resulting in injury to the tester.	Due to inadequate publicity, not enough people were attracted for crowdfunding.
Probability	0.33	0.2	0.2
Impact	0.33	0.3	0.5
Category	Technology	Technology	Financial
Root Cause	Technical failure	National Defence	Poor publicity
Triggers	The experiment didn't get the result it should have	NCX has strong individual ability	Crowdfunding is not up to standard
Owner	Develop Department	Testing Department	Financial Department & Marketing Department

ID	T-4	T-5	T-6
Risk	Be refuted	Misuse	Inadequate design
Rank	7	6	5
Description	Conservatives would challenge NCX and march against it.	Terrorists may purchase NCX from certain channels and then carry out terrorist activities.	The bearing capacity of children and the elderly is not considered, or the ergonomic design is not up to standard.
Probability	0.15	0.1	0.2
Impact	0.2	0.3	0.15
Category	Structure	Structure	Technology
Root Cause	External	External	Design is not up to standard.
Triggers	NCX launch is in conflict	NCXs are sold to terrorists	Dissatisfied after use.
Owner	Project Manager & Marketing Strategy Department	Project Manager & Marketing Strategy Department	Design Department

Risks Prioritised:

1. O-1 Great Market Demand
2. O-2 Military Investment
3. T-1 Experiment failure
4. T-3 Insufficient funds
5. T-2 Test injury
6. T-6 Inadequate design
7. T-5 Misuse
8. T-4 Be refuted

8.5 Risks Response

8.5.1 SWOT

In order to provide solutions to various risks, we still use SWOT analysis, and analyse how to deal with the risks by combining the opportunities and threats with projects strength and weakness.

Internal External	Strength	Weakness
	Opportunity	Threats
	SO 1. Adhere to the use of non-invasive BCI. 2. Constantly innovate in design and ergonomics, design the most symbolic NCX used by people. 3. Provide the military with defensive NCX to help provide national defence forces.	WO 1. Actively seek non-invasive BCI solutions and cooperate with world-renowned universities and research institutes. 2. Use appropriate advertising and welfare to promote NCX, so as to obtain sufficient funds.
	ST 1. Provide sufficient funds for technical research. 2. Seek help from relevant government departments in time, and may get support from the government and the army in advance. 3. Promote the market concept of helping the disabled and correct values.	WT 1. Strengthen the screening of employees to ensure that they are technically qualified. 2. Strictly control the selling way of NCX to ensure that each NCX could be associated with a certain user. 3. Strengthen the protection measures during the test to minimise the injury. 4. Continuously improve the power system.

8.5.2 Detailed Response

8.5.2.1 O-1

Enhance – Strengthening the theory that NCX could improve the quality of life of disabled people and seek cooperation opportunities in the industrial medical industry.

5.2.2 O-2

Enhance – Make special military defence NCX for the government and army, sign agreement and contract with the official to obtain official support.

5.2.3 T-1

Accept – Summarise the failure of each experiment to ensure that the process is in the right direction.

5.2.4 T-2

Avoid – Strengthen safety education for testing personnel, prepare protective equipment of good quality, and minimise injury caused by test accidents.

5.2.5 T-3

Mitigate – Propagandize the product before and after phase 1, and contact the users in advance.

5.2.6 T-4

Accept – In case of resistance, the marketing strategy department will conduct public relations and state that the idea of the project is to improve the quality of users' life.

5.2.7 T-5

Avoid – Control the sale of NCX strictly, ensure that every NCX could be traced back to the buyer, and carefully verify the buyer's identity (it will not violate the privacy of users).

5.2.8 T-6

Accept – Continuously collect customers' opinions, continuously improve product design and user experience, and ensure timely and high-quality customer service.

8.6 Risk Monitor

1. Add the risks with high possibility and impact into the project plan, and Make a careful plan, to ensure that the project is monitored during its exposure to various risks.
2. Assign a risk manager to each considerable risk at the appropriate time in the project schedule.
3. Risk monitoring should be a continuous process in the whole project life cycle in order to reduce the treats and enhance the opportunities.