

## **MORPHY THE MULTIFUNCTIONAL CORDLESS GARDEN TOOL – PRODUCT DESIGN PROJECT**

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**Abstract:** This paper is about designing a garden hand tool that means a full product design from the market research to the shape and part design. Main guidelines of the international product development project were given by Robert Bosch Power Tool Ltd. Universities of the contribution pointed on the main milestones and deadline. We assess market requirements and user needs. Our group has found possible field of improvements that can be competitive with current products and even completely new.

**Keywords:** *multifunctional product, product design, cordless, battery, garden tool, market*

### **1. Introduction**

The international product development project was contributed in cooperation between the University of Miskolc, Hungary and the JAMK University of Applied Sciences, Finland. The process of the project was supported by both Finnish and Hungarian supervisors and also by the representative of Bosch. From different fields of engineering studies the students worked in a real life case for the multinational company. There were two student groups working separately on the same task. The subject of the project was about creating a cordless gardening tool with at least three functions.

The name of the tool is Morphy that comes from the Latin word: metamorphosis. It supposes to mean what our designed tool is capable of. Morphy is a lawn and garden tool, multipurpose and battery operated. It is a revolutionary cordless garden tool in its area. What people need is to make various garden tasks easier and entertain with additional technologies like smart applications, achievement system, capability of smart glasses and revolutionary design with changeable housing colour. We truly believe that gardening tasks can be fun and could mean so much more than something to get over it.

We would like to connect an ordinary multifunctional product with the latest technologies. Create your own tool, put the attachment and battery on and the fun can start right away!

### **2. Market research**

To fulfil all the requirements from different sides, a market research had to be done; users' need had to be collected. We also had to know what users still do not know. It gives an advantage if we can come up with something new, so we need to know their environment perfectly.

The real field of competition lies in the multifunctional tools within the gardening area. Fast development of cordless technologies was the start point of innovation in the lawn and garden area. Nowadays our technologies make it possible to have effective battery operated tools, which can make our work easier. Multifunctional and compact tools are becoming more and more popular these days since the users would like their tools to consume less space and want to do as much job as they can with one device.

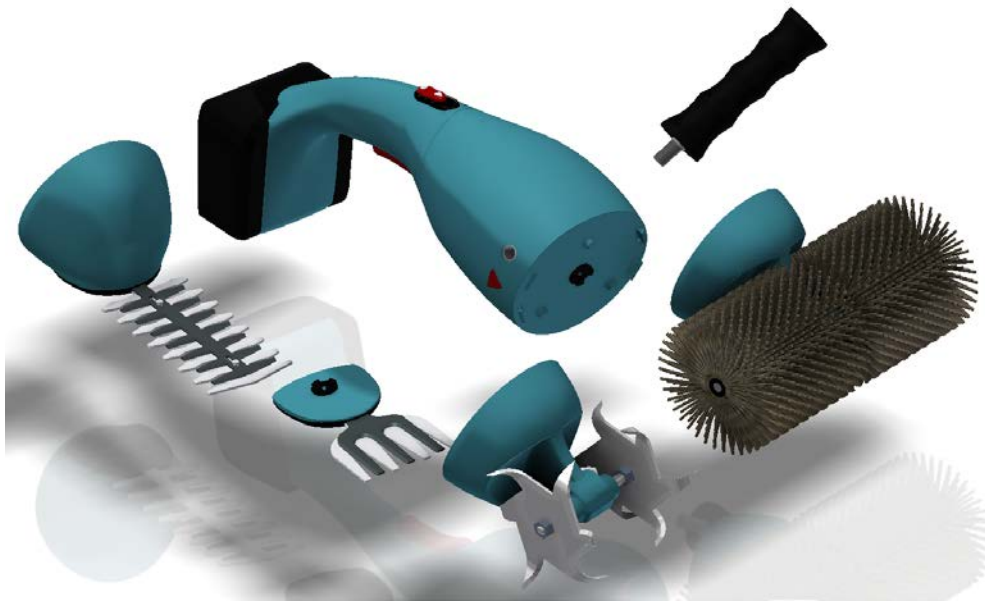


*Figure 1. Morphy with its attachments*

According to the online market research and gardening related forums we collected user feedbacks of the cordless gardening devices. The most annoying features are the lack of power and the short working time. The four things that users appreciate are easy handling, light weight, easily attachable battery and that the tools can be easily switched. To find out the competitive products for the concept Morphy, some research had to be done. Morphy was compared to the most similar tools available on the markets like TEHO, Bosch and Chameleon.

Our product emphasizes the things users really need. In the following there the initial concept and key messages for the user are listed.

*Table 1*

*Key messages to user*

| <b>Performance</b>                         | <b>Ergonomics</b>                                                            | <b>User benefits</b>                                                         |
|--------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Charging time<br>Speed<br>Battery capacity | Form of handle<br>Accessibility of operating elements<br>Balance of the tool | Light<br>Compact<br>Powerful<br>Simple to use<br>No memory effect on battery |

There were also requirements from the side of Bosch but these were related somehow to compete with other market products. While focusing on the needs and requirements of the users, the principal's needs had to be kept in mind. The concept of a multifunctional cordless tool pointed the guidelines (battery size, operation time, weight).

Principal is an economic- actor, who choose, pays and use the product documentation. The most important element of user centred quality is buyer's satisfaction of the product. Because user buys the product, he/she wants to get value for his/her money.

### 3. Creating concepts

Morphy was created by using many alternative methods. The goal was to create something new, there needed to prepare a market analysis. This way the risk of creating something already existing is minimized.

Brainstorming was used during the whole project in different situations. The main brainstorming sessions took place already at the beginning of the project. Using this method helped us first to find of our goal and then later to generate concept in every possible subject. From the ideas some were chosen and some were left behind.



Figure 2. Brainstorming about the word “garden”

The manifestation of the developed concept is Morphy. Among the countless ideas rose up this garden tool that is based on modular principle. The name of the product can be variable depending on what users want and how marketing can touch them. If the shape of the product can be compared with a well-known thing, it is often useful to use it as an advantage. In our case Morphy is more or less shaped like a dolphin. Due to its interchangeable components, Morphy offers great flexibility for the users. It is adaptable for the particular job and for the user needs.

The research phase is followed by the feature-based conceptual design. Based on the tool's main and sub-functions a list and physical assignment has been made. The preliminary design of the building blocks was constructed here. The created solution was selected from the best variants with Copeland procedure that is based on a positive criterion consisting system of criteria. The evaluation criteria are presented in the following:

- Simplicity and Cost: It contains small number of parts and it is easy to assemble. How much does it cost to the manufacturer to make the tool? If something is simple it is not expensive so much.
- Innovation: The technical innovation that catches the user.
- Energy usage: How efficiently the tool use the energy stored in the battery?

- Handling: How obvious the interface is and how clear the tool's shape hints to the right usage.
- Comfort: In which conditions the user uses the tool and how clear and conspicuous the feedback is from the tool.

The adequate level of comfort of users is provided by ergonomic considerations. The human-centred design helps prevent the loss of comfort for the users, in case of a longer period of usage.

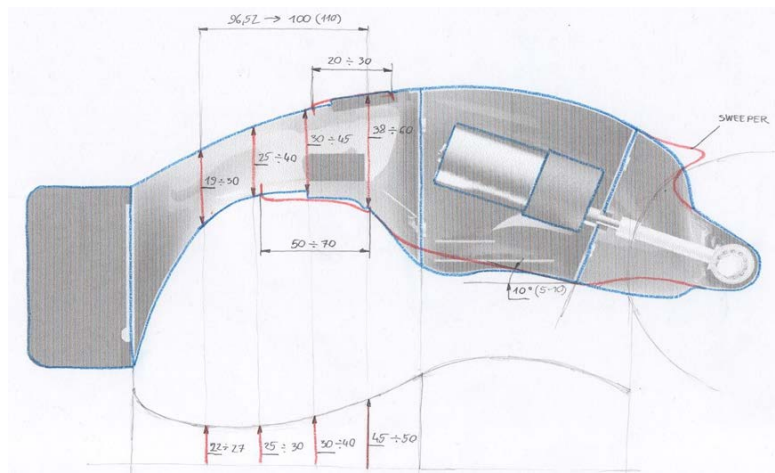


Figure 3. Sketch of the back grip and body

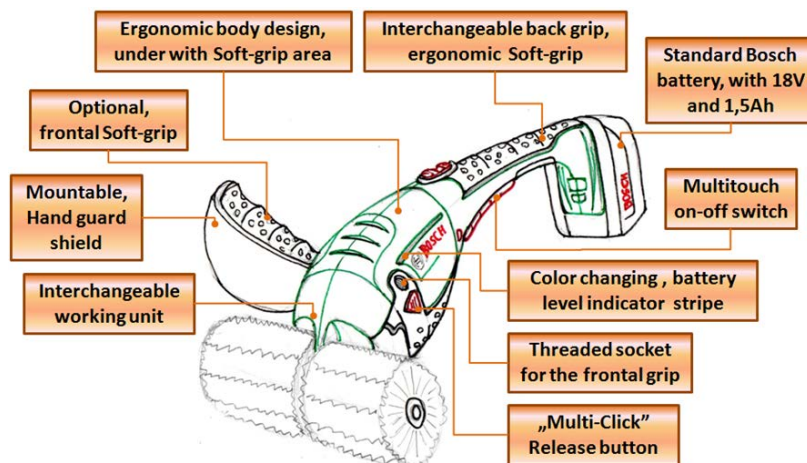


Figure 4. Charming features on the garden tool

Anthropometric dimensions for the ergonomic body design came from measurements, and professional literature research (EN 14866). Main target was the back grip, because this subpart must be comfortable with the switches.

The design of the frontal grip takes into account the average size of the fingers and their distance from each other. There are threaded holders on both sides of the main unit to

support the right and left-handed usage. To ensure the safety of the users, the frontal grip can be provided with hand guard cover.

#### 4. Solutions

Based on the functional list of Morphy the main components can be determined. The body shape, the shape of housing is based on ergonomic considerations, but it takes into account the function fulfilment of the functional components.

After long deliberation, we have chosen the main attachments, which are the hedge trimmer, sweeper and cultivator. Also some promising attachment ideas have been predesigned like weed puller multi tool and weed sweeper.

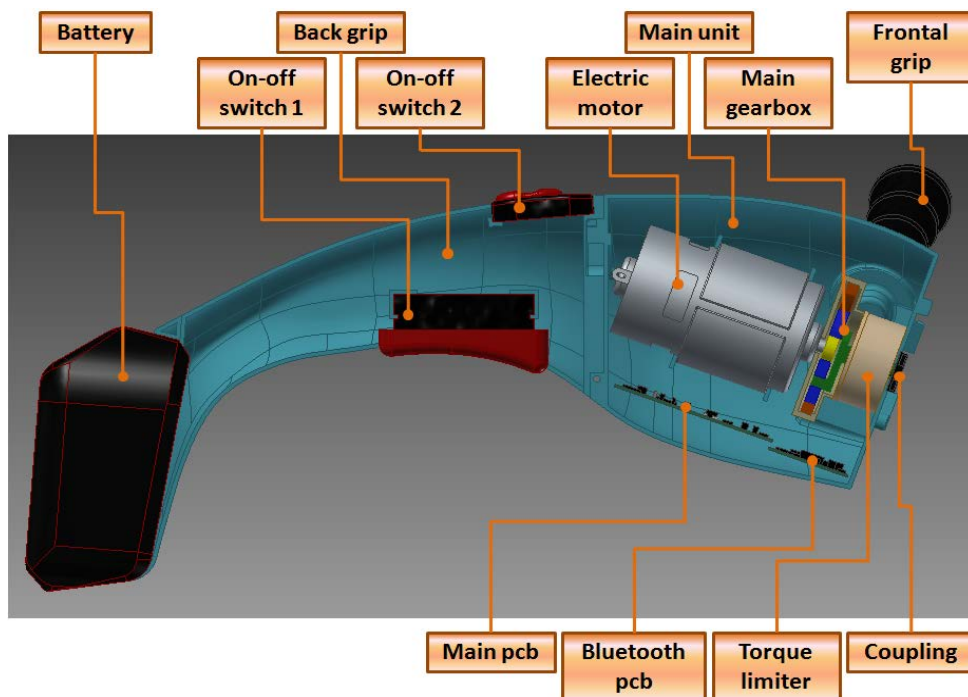


Figure 5. Preliminary internal structure of Morphy

Engineering calculations are based on the functional analysis of the internal structure of Morphy. We have chosen one solution for the structure and tried to estimate the related main data. These were the power supplied by the battery, and the torque what we need for the approximated function. Going through the design process, we have got the rough components with their size (motor, couplings, planetary gears, shafts).

Among the possible attachments, the hedge trimmer attachment has the highest rotation speed. The output rotation speed have to be around 3000 rpm, in this case the further transmission ratio reduction can be easily implemented.

For torque limiter we use a common mechanism. It has 4 main parts. It has a cylinder to carry balls, balls, a shaped counterpart and a spring. A spring squeezes the two cylinder parts. If the torque is too big the two parts can rotate on each other because of the balls.

#### 4.1. Sweeper

Sweeper is the tool of health and cleanness. It is already alone a multi-purpose tool to clean the greenhouse, floor, tables, shelves, plant pots and all of your garden tools. It can help not only in the garden, but also with cleaning anything from snow and from dust. With the pole cart extension tool of Bosch, high places can be reached. It can be equipped by several types of brushes, stiffness and size of the threads can change. It is the perfect solution that fits every hand and helps for every age to make cleaning more fun.

Calculation of the attachments was made based on the power need of the working main function. The power consumption comes from the needed rotational moment of the tool's shaft. It was calculated from the force needed to push away the specified amount of material.

Planetary gear can be used in the sweeper attachments to reduce the rotation speed near to 1000 rpm. It was necessary to gain as much torque as possible for sweeping. The insight components of the sweeper are presented in the figure below.

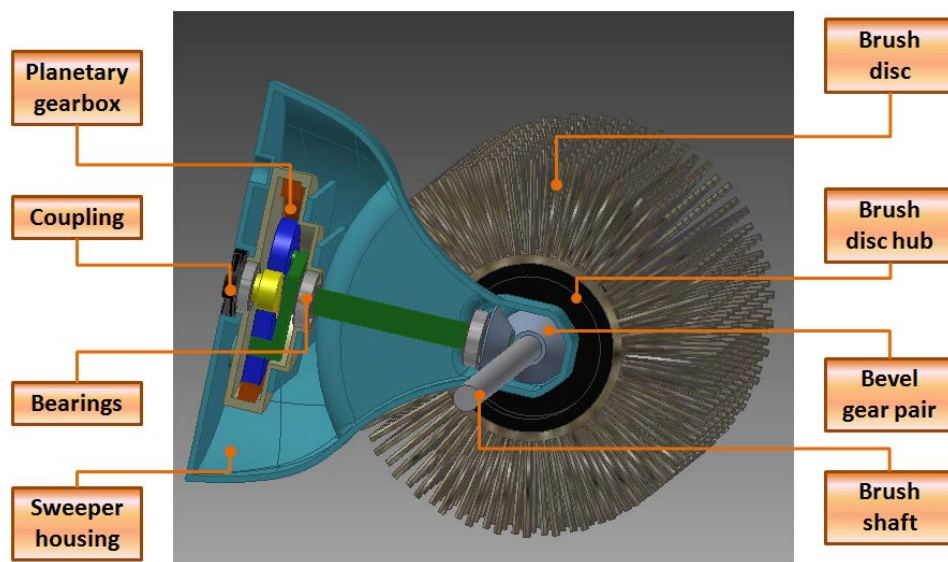


Figure 6. Section view of the sweeper attachment

Summarized data for the sweeper:

Sweeps dust/soil/dirt/sand from narrow places

Max effective height of swept material: 50 mm

Rotation speed: ~ 1000 rpm

Dimension:  $\varnothing 80 \times 165$  mm

Estimate continuous operational time in normal use: ~ 40 min

Power need in normal use 42 W.

#### 4.2. Cultivator

A small one-hand cultivator tool is another attachment for Morphy. Cultivator tool is designed to loosen the ground in small vegetable gardens and greenhouses. It digs, blends soil with fertilizer. Cultivator has bended steel blade to do perfect work.

For the cultivator it is also a good solution to use a planetary gear for speed reduction. In this case it transmits the 3000 rpm rotation speed (which comes from Morphy) to nearly 100 rpm. It means nearly 30 transmission ratio, which can only be carried out in two stages in small size. The other side of the cultivator tool's gearbox is a simple bevel gear pair, with 1 to 1 transmission ratio, to turn 90 degrees of the direction of rotation, as in the case of the sweeper tool.

Our calculations gave only a rough result. It is based on the power of rotating an amount of soil. The real value varies a lot depending on pushing force and friction.

This idea uses the same size components and parts as sweeper for modularity. Difference between sweeper and cultivator design is that the cultivator has stronger blade shaft and size of shaft bearings. Cultivator has different rotating speed so different gearbox is also needed.

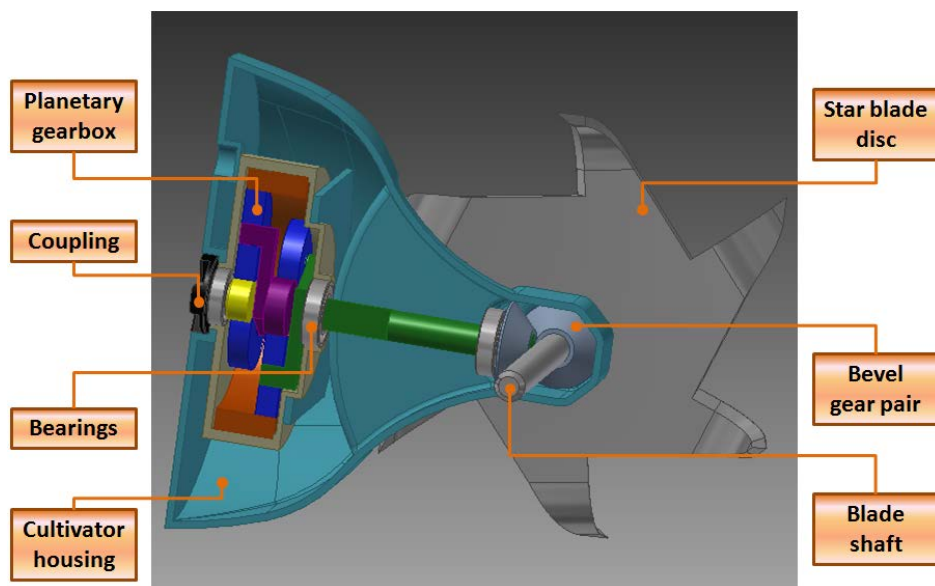


Figure 7. Final design of the inside of the cultivating tool

#### 4.3. Weed puller rotary tool with spiral shaped blades

Weed puller multi-tool is a multifunctional easy-to-attach extension. The main concept of the spiral shaped bladed attachment comes from the paint mixer and the rotary weed puller what are used normally with drilling machines, or battery operated drill-drivers. The auger type tools with half to two pitch can be used for hole digging and soil, humus mixing. With a special geometry blade, this is capable of doing all those jobs. The blade spiral angle is increased, and beside the rotating shaft is undercut. This geometry allows the tool to be able

to dig holes and also weed is entangled in the rotating blades. This tool could stand alone, as it can be sold even with other Bosch products as an extension.

#### **4.4. Weed sweeper**

Weed sweeper is a weed cutting attachment. This is a special purpose tool to cut grass and weeds from narrow places. This high speed tool with hard brushes cut the weeds out like a string grass trimmer, but this tool rotates in vertical plane. The structure of this attachment is related to the design of the sweeper.

#### **4.5. Bush shaper**

Bush shaper tools are the ordinary function of the present Bosch products. The basics for these grass trimming and hedge cutting function came from the product Isio. In our concept, it was a basic function what should be implemented in a multi-functional garden tool.

### **5. Smart solutions**

Customers always would like to feel better from their new products, and their expectations are growing year-to-year. Nowadays the biggest trend is the smart gadgets. Other brands try to make everything smart, and this will cause the “smartness” to become a future basic expectation.

Our idea for this problem is the Personal Gardening Assistant (PGA). This application will run on the basic operation systems, which will be compatible with smart phones, glasses and watches. The main function will be the connectivity. Users will be able to connect their gadgets to garden tools and with this they will easily get information about the tool furthermore they will have the option to control it. Smart solutions will open a new field on the market.

#### **5.1. Virtual reality**

Virtual reality can be a huge hit in a few years, and that will be a good idea to think about the smart gadget options. In the future users will be able to be more professional with the Bosch applications.



*Figure 8. Working area detection via specified prerequisite*

It will also give advice about the most convenient tool, and if they do not have it also recommend a nearby reseller.

Working area detection can be also a huge hit in the future, because the user will easily calculate how much time it will cost to do the work.

### **5.2. Experience based levelling**

Nowadays other trends are the micro transaction games, which are about that people will always want to get to the other level, and compete with other people and get their well-deserved prizes. These games give the idea to make this application to more game-like. But every game need a competitive system and this is the experience base levelling. If people buy Bosch products they will get experience, and they will level up and also gain sale points.

Basically we want to use the human nature. Everybody wants to be better than the others. This is why we need experience point, because with these the user will level up, and the level is where they can compete with each other. Sale point is very different from the last two. The user can consume them to get different prizes depends on their level. For example at early level they can get only some euro discounts, but later they will get bigger prizes; which means percentage discounts. This system makes the user more loyal to Bosch. It will be like a point card system.

### **5.3. Positive feedback**

Every game has to give positive feedback to the users. The absolute basic components can be the achievements. In this application the achievements will be the most important experience and discount source. For example Bosch can make competitions for local communities in a seasonal holiday topic, where the competitors will get an achievement.

### **5.4. Tie-in sales**

Tie-in sales will be the main profit source of the application. Achievements will give a discount for another Bosch family product. For example with a gardening tool they will get a Bosch Home discount. The user will go to the reseller store and see a lot of brands, but they will not care about them, because only one company give them a discount already, and this can be enough for an average user. This will also increase the loyalty for the Bosch products.

The previously detailed game-like systems works well when connected. They bring the users closer to Bosch and closer to their hobbies.

## **6. Failure mode and effects analysis**

Failure modes and effects analysis (FMEA) is a step-by-step approach for identifying all possible failures in a design, manufacturing or assembly process, or a product or service.

The first stage of FMEA was made for the motor, gearbox and housing.

Once actions have been completed, re-scoring the occurrence and detection is necessary. In most cases there is no need to change the severity score unless the customer decides this is not an important issue.

## **7. Purchasing**

In this project, the purchasing was a major part for gathering information about the suppliers and marketing prices.

At low production rate the injection moulding price is significant so this is where the company can cut expenses and increase the profit. But at higher rate, the battery, charger

and dc motor can be the components where the company can make an extra profit if they can manage to cut the cost.

## **8. Summary**

Using the full scale of product design tools like market research, risk analysis, FMEA, design book, brainstorming, solution evaluation methods... etc. showed the future way of garden tool improvements. We have made a preliminary model of an ergonomic battery operated multifunctional tool for garden works.

## **9. Acknowledgement**

The whole project team feels proud and privileged to work with each other and get to know new ways of thinking and working. Warm thank for Dr. József Kakuk for enabling this opportunity to work with Bosch. We are also grateful for our supervisors from Hungary, Vadászné Dr. Bognár Gabriella, Kelemen László and Dr. Szabó J. Ferenc, as also for our Finnish supervisors, Jorma Matilainen, Petri Luosma and Anneli Kakko.