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A WAY TO A RADICAL INNOVATION: A CASE STUDY

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1 Introduction

A radical innovation, as its name already implies, radically interferes with the current technical solutions, current markets or it means a brand new technical solution and a new market is created. It is a known fact that a new product that has been accepted by the market and has become commercially successful can bring its producer a huge profit. It poses a question: how to come to the so-called radical innovation – to such product? What factors should be taken account of and to what degree?

Innovations can be divided into two larger groups. The first group is incremental innovations and the other one is radical innovations [2], [3]. Incremental innovations are innovations that are being introduced all the time within a company and they have no revolutionary impact on the structure of the company or the market. This is an ongoing process of changes and innovations within a company. A radical innovation of a product, process or service can bring about dramatic changes that can re-shape the market and a company. A radical innovation should meet one or more of the following criteria [2]:

- an entirely new set of performance features
- five times or greater improvements in the existing performance features
- a significant (30 percent or grater) reduction in cost

Products should not serve their own purposes only but should form part of a company's overall strategy and expansion of its activities. A suitable product with radical innovation characteristics gives the company an opportunity for growth and development. A suitable product means that it can incorporate the company's know-how, it can be launched on the market and it can be produced by the company. Therefore, it is vital that a company should recognize such problem in the environment.

In his book, Cagan [1] presented the principle of recognizing a problem by means of a detailed analysis of SET factors, as he terms them, that serve the purpose of recognizing an opportunity for a new product. For the purpose of this article, the factors have been further expanded and applied in the field of law as well as placed into the company, searching for a new product. Searching for a new product or recognizing a problem has been divided into several steps, which was made possible by a detailed focusing. The beginning is very important since the products are the basis for market definition of activities [5] and the basic function of the product range is defined. A detailed survey of the environment and the use of the know-how from the same environment should enable a radical innovation, while a radical innovation is not possible with little knowledge and poor survey of the environment. For the purpose of searching the solution, we used the teleological model, where the focus is always on the final objective although the latter can change.

A radical innovation will be shown on the example of a combined spreading device, which has been developed out of the needs on the market and it simultaneously coincided with the company's strategy, its know-how, productive capacities and technological facilities.

2 Method

2.1 Radical innovation and the company

The type of innovating within a company depends on the company's strategy. Some companies – the leading ones – opt for the strategy of constant innovating, while others follow them and adopt the existing innovations. Radical innovations are therefore usually developed within the leading companies, which requires some activities. A better planning and a bigger effort in the development areas are required; however it increases the costs and the risk of failure [4]. A successful introduction of such innovation should lead to better financial results and a bigger success in general. However, it is a surprising fact that less than 10% of new products are successful on the market [5]. The speed of developing a radical innovation is very important and it can be a huge advantage over the competition on the market. This way, the development costs are amortized before the competition arrives with its own products. When a company is too slow, the competition can decrease its profit.

The acceptance of an innovation on the market plays an important role. A wrong timing for presenting a new product on the market can lead to failure while a perfect timing can lead to success. The customers should be ready for an innovation. Figure 1 shows how an innovation is being accepted. It is first accepted by innovators and early customers. These are people who are pioneers in all aspects when it comes to accepting innovations. The early majority of customers is very cautious but it accepts innovations earlier than the skeptical and late majority. Latecomers are the last to accept an innovation and they do that only once it has almost become part of the tradition.

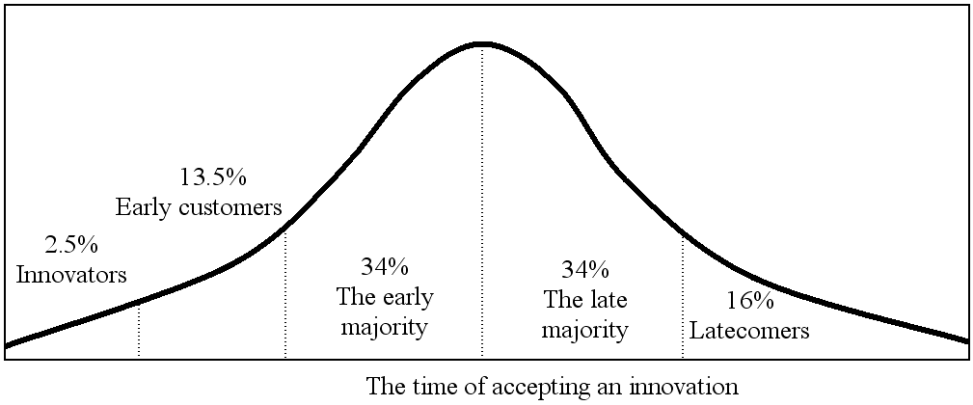

Figure 1: The process of accepting an innovation [5]

Companies, the middle-sized ones in particular, follow the catch-up strategy. Therefore, they follow the innovations on the market while they themselves improve their products slowly and cautiously. They are much more focused on improving the production system, compared to innovations on the product [4]. They compete with lower prices and they continuously increase their production volume.

A radical innovation can have a massive impact on a company, compared to an incremental one. Incremental innovations mean a neutral approach to company's business activities with marginal changes only. On the other hand, a radical change can lead to a dramatic growth while a poor innovation can lead to a decline or even bankruptcy. A radical innovation can open new markets [2] and an incremental one can improve the position on the established target markets.

A radical innovation is possible only if a company takes a broad enough approach to the search of solutions. The environment where a solution is being expected should be surveyed well enough and supported by a wide range of expertise. Otherwise, a radical innovation is not possible.

2.2 The idea and the design process

A problem well-defined is half solved (Charles S. Kettering). However, the problem should be recognized first. The problem recognition phase is irrelevant for the design process according to VDI 2221 as it uses the defined task as a basis. Other authors also do not pay special attention to the problem recognition phase. Figure 2 shows the first two phases of the D&D process that complete the development process [7]. The development process is part of the design process, connecting the problem recognition phase with the design requirements and embodiment of the problem. The idea's origin is not highlighted but it definitely sets the design process in motion.

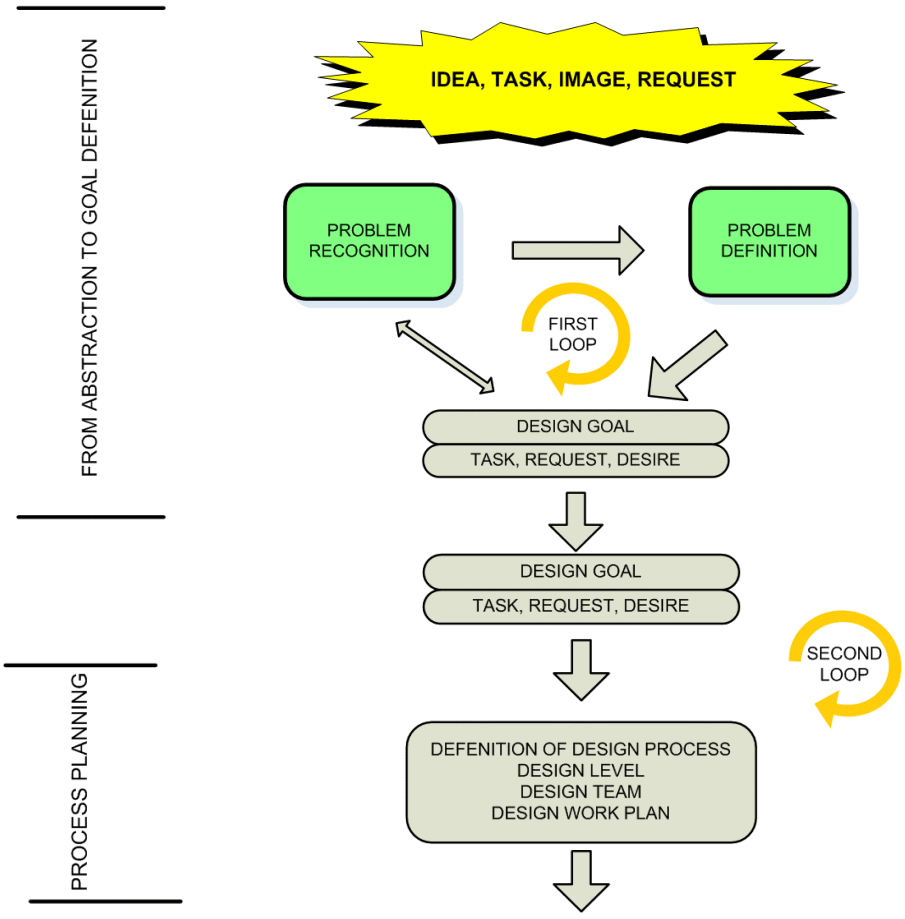

Figure 2: Development process [7]

The problem recognition phase, followed by the problem definition phase, where the design requirements eventually come from, is part of the initial phase of the D&D process, where abstract shapes are transformed into design requirements definitions. They complement each other by means of the iterative process, developed in 1983 and upgraded in 2001 [7]. The iterative process is particularly useful during the problem recognition phase (Figure 2). A multiple iteration between the problem recognition, problem definition and the design process becomes increasingly recognizable and clear.

Cross and Dorst suggest that there is a difference among problem definitions, from completely defined to undefined. Undefined problems leave more freedom and consequently more creativity because the problem is being solved during the design process. The number of scientific articles, stressing that the areas of problem and its solution should not be separated, is increasing. According to these articles, both areas should be examined simultaneously as the problem is developing together with its solution. Maher [8] was the first author to find the correlation between the problem and its solution and simultaneous development of both areas. He termed the creative design model the Co-evolution model. It is based on constant iteration between the problem and its solutions [6]. Both of them are being developed during the process. Cross and Dorst slightly upgraded Maher's model so that a constant iteration between both areas leads the design process to a closed circle problem - solution (Figure 3).

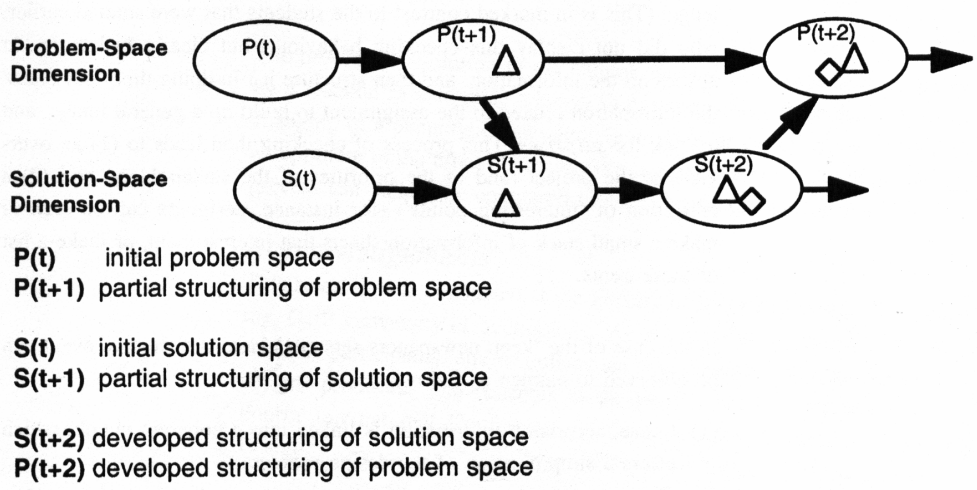

Figure 3: Iteration between the problem and its solution [6]

2.3 In search of the problem

It has already been mentioned that the biggest challenge for a company, searching for a new product, is to find a product that should be a success on the market. Therefore, we believe that the notion of the search of an idea or a problem in general is irrelevant as it should be considered in association with a company. Solutions to these problems can mean a radical innovation for a company. Otherwise, the success of the product on the market in the circumstances of such strong competition is in jeopardy. A company can enter the market with a substantially revised existing product or with a product that creates a new market.

The process of searching for a problem that might be of an interest to a company and whose solution might be welcome on the market has been divided into three steps. These steps are

the initial phase of the D&D process, where abstract shapes are transformed into design requirements definitions. Attention should be paid to a most comprehensive survey of the environment where solutions are being sought and as much expertise as possible should be incorporated. Seeking the solution, the focus should always be on the final objective. However, the objective can change during the process. It can also be indicated by a teleological development model.

Step 1: Market area is selected in step 1. First, the company's strategy, its know-how and productive capacities are explored. According to the product range, the areas are defined or, in other words, company's business activities are defined from the market point of view. Limitations and incentives are defined according to the information on the company. With a view to limitations, incentives, balance between individual areas and the management's opinion, the most suitable area or market definition of the business activity for further studies is selected.

Step 2: In step 2, the factors for the selected area are explored in order to gain the information. Several sub areas for the selected area are generated by means of creative methods and information, gathered through previous researches. Using the SWOT analysis and management's assessment, a sub area is selected. By means of interviews, surveillance and existing products, the needs, fantasies and wishes are defined, which marks the beginning of the problem definition process. A certain problem is again selected on the basis of limitations and incentives, accompanied by economic assessment and the management's opinion.

Step 3: In step 3, the final scenario is finalized and improved together with the problem definition that serves as a basis for the diagram of the work process

STEP 1

Step 1 is shown in Figure 1 and it mostly includes gaining information within a company. Each task is described below.

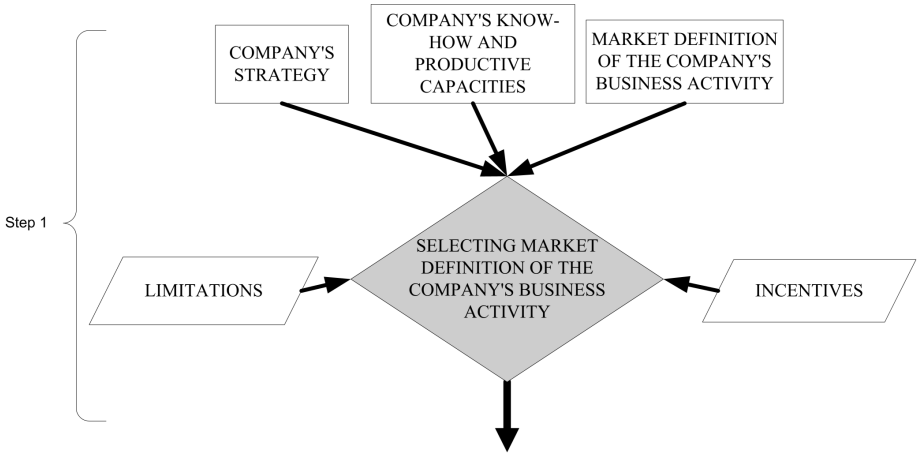

Figure 4: Digaram of step 1

Company's strategy

If a company has the strategy of its future development the areas of its planned activities should be deduced from its orientation. A company's strategy can predict its target market or even the task of a product development itself [5]. The long-term strategy can thus be taken as the task itself or even the defined problem. If a company's strategy includes an increase in production only, without new markets or a new activity it does not help much. An organization is there in order to achieve something. Its specific mission or purpose is usually clear. A company's strategy and mission can usually tell what direction the company is going to follow.

Company's know-how and productive capacities

Scientific and technical skills as well as the productive capacities are explored within a company:

- Basic skills that the company already possesses. They include its development and technological skills, required for the existing range of products.
- Skills that the company can acquire. They include skills in connection with the technology of production and basic skills within the company.
- Educational structure of the company and human resources development. The educational structure of the company is explored with special attention to the development, technology, marketing and production. The ratio of women to men in the production is also of an interest.
- Technological facilities of the company. It is shown in the section with the information on the evaluation of the manufacturing quality, use of potential automated procedures, suitability of the manufacturing method with reference to the use of the element...
- Type of production. It includes mass production, individual production and small-scale production.
- Size class of the existing products. It includes micro products (a couple of millimetres in size), small products (table size), medium size products (room size), large products (movable with ordinary means), mega products (immovable or movable with special machines).

Market definition of the company's business activity

The current good image of a company on the market is very important. Therefore, the first focus is on the markets where the company is well known as well as on the markets, connected to these markets. The company's production activity should be defined on the basis of the needs that are fulfilled by these products and not the products themselves as different products can fulfil the same needs, wishes and fantasies. In our case, the best starting point is probably the company's activity. It can be defined according to the product definition of activities, which means a definition according to the products that are being manufactured, and market definition of activities, which means a definition according to the commercial needs on the market, where the company is present [5]. From the product function viewpoint, market definition of the company's activity could be referred to as the basic function of a product range. Market definition of the company's activity could therefore be taken as the basic function of a product range that fulfils the customers' needs.

Limitations and incentives

Each company is limited by frames that limit the manufacture of some products. Consequently, a company with a good knowledge of a specific area or technology can become more successful in a certain business. Limitations can also act as incentives since only the available resources can be used. Whether it has a positive or a negative impact on the product development depends on the problem. Besides the know-how and productive capacities, tradition should also be taken into consideration as it can sometimes play an important role when making the decision regarding the potential product range.

Selecting the most suitable market definition of the company's business activity

No creative methods are mentioned in the diagram (Figure 4). Before making the selection, using the creative methods, one should always try to extend the range of possible solutions. In includes particularly the areas, similar to those of the company, that were not considered as possible solutions after the selection process. The personal opinion of the management is also a strong factor of influence. It should be pointed out that the decisive criterion can also be the balance among different ranges of products. One product range should not present more than 50% of a company's production volume. This way, the reliance on a particular range of products or a specific product as well as the risk of recession in this area is reduced.

STEP 2

Step 2 (Figure 5) is not as exactly defined as step 1 as it is necessary to find as many information as possible on a particular area, relevant for its market definition of activity.

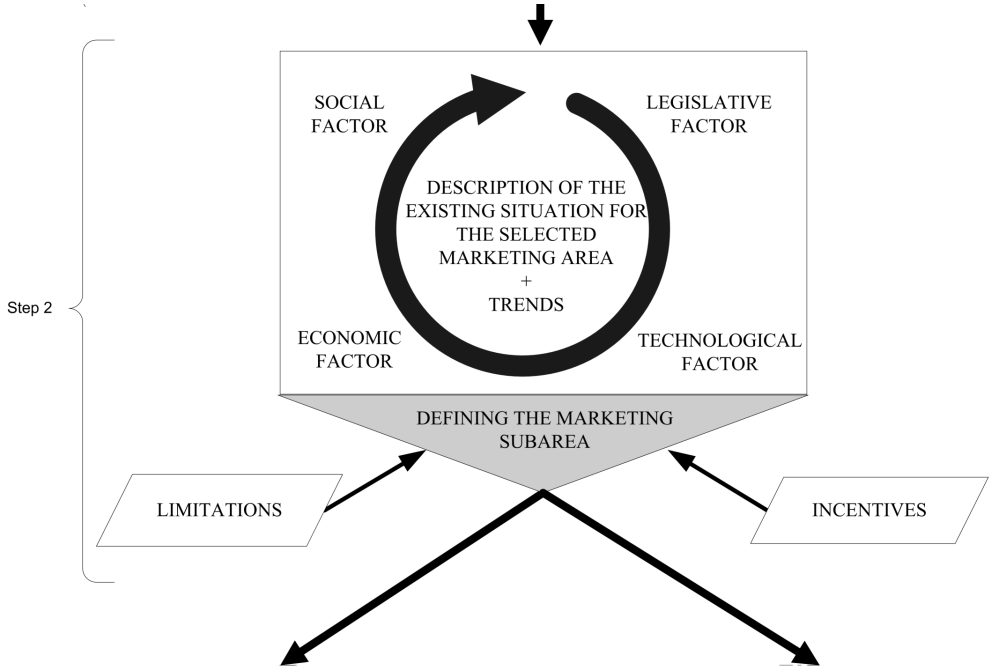

Figure 5: Diagram of Step 2 of the process of searching for new products

Factors

There are many factors, influencing a successful sale and use of a product. All the influences were put into four factors of influence: social factor, technological factor, economic factor and legislative factor. Social, economic and technological factor are known from the literature [1]. In our opinion, the legislative factor is equally important and it has been added to the list. However, in order to eliminate some trends it is not enough to monitor the current influences only but also the influences in the future. As many information as possible should be gathered for each factor and we might try to deduce an opportunity for a product. This is still a matter of an opportunity, not a product. Information can be gathered from the mass media, statistical offices, scientific literature, magazines, internet, institutes, producers, consumers association...

Social factor

The focus of the social factor is on the culture and the social interaction. As many information as possible, including the future trends, should be gathered for the selected marketing area. The following guidelines should help:

- Demography (married, unmarried, size of families, children...)
- Health (people with an active life-style live longer...)
- Environment (environmental protection, environmental impact, climate changes)
- Culture
- Leisure - (holidays, hobbies...)
- Entertainment

Economic factor

The economic factor means the financial view of the activity and area. The following items can be used in order to determine the positive financial flows:

- Growth of the selected areas in the past and future trends
- Size of the area
- Purchasing capacity and future trends
- Value added (profit to the resources and work ratio)

Technological factor

A good understanding of technology, scientific discoveries and thus the future technology should contribute to a clearer vision of the current situation in the analysed area and should lead to the idea of what is to be done. The following items should help:

- Current and future technology
- Technology that is being applied in the company
- Patents and new technologies
- Technological complexity of products
- Researches at technological institutes

Legislative factor

The law in a specific area can significantly influence the product function or even its existence. On the other hand, provisions and regulation can also be a source of new products. Three years ago, for example, after having carefully examined the European legislation,

which was going to be introduced to Slovenian companies too, the Eurocontor company started to develop protection devices for the feedingstuffs industry, in accordance with the HACCP system requirements, introduced by the health and hygiene safety of foods act. In Slovenia, it makes sense to examine:

- EU Regulations
- EU Directives
- Slovene legislation
- Regulations, directives and laws in course of preparation

Selecting the most suitable marketing sub area

Using the analysis of individual factors, the gathered information should be reviewed from the limitations and incentives viewpoint. The analysis should include the SWOT analysis. One of the creative methods should be used before the SWOT analysis in order to generate several possible solutions from the gathered information and facts. Besides the SWOT analysis, the selection process should include limitations, set out on the higher level. One should be careful to select the marketing sub area, where a company can benefit from its advantages and circumstances on the market. The decision about the product is not made on this level. It is only the decision about the sub area of market definition of activity or even the opportunity for a new product.

STEP 3

Step 3 means searching for needs, fantasies and wishes, serving as the basis for subsequent discovery of an opportunity for a new product (Figure 6).

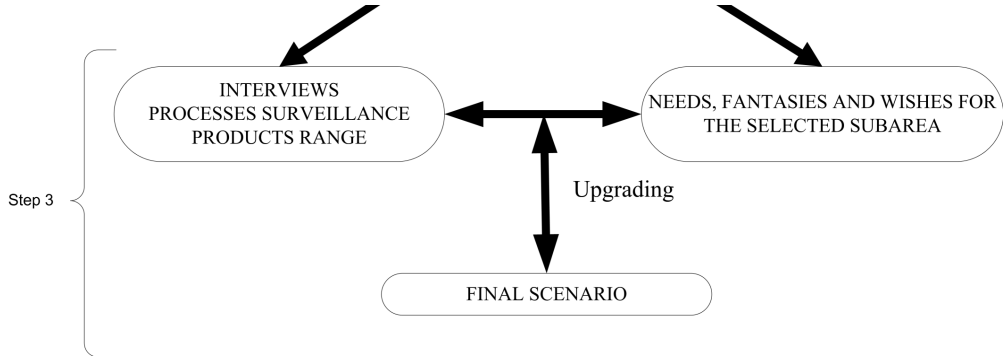

Figure 6: Diagram of step 3 of searching for new products

Discovering the opportunity

Unfulfilled needs always exist in the environment. Those who are able to recognize them and respond to them are successful [5]. The answer to an unfulfilled need can come in the form of a radical innovation that successfully fulfils the need. Together with the marketing terminology, the need could be defined as search for a suitable product function [7]. The success of this method lies in the fact that we are able to find such needs in the environment - in the sub area that has been selected as the most suitable one, according to the opportunities, reflected in the form of customers' unfulfilled needs, wishes and even fantasies [1]. It is possible to recognize them by means of interviews, work processes surveillance, polls, analysis of the products, currently present on the market [5]. Regarding the details of the

information, it is best to start with processes surveillance, which provides general information. A poll enables a systematic gathering of specific information and interviews are the most personal form of gathering information. With interviews, it is possible to assess an individual's personal feeling regarding his or her unfulfilled needs, wishes and fantasies.

Making the final scenario

Two issues are important when it comes to a product. First, the market should want it, like it and it should have a practical value. It is the answer to the user's fantasies and should provide him/her with something slightly more than expected. Its definition should be neither too wide nor to narrow. The scenario should serve the purpose of a concrete treatment of an individual user while keeping the core of the problem and the way of thinking. Together with the scenario itself it is useful to determine its elements in a bit wider, impersonal form. The initial scenario is short and it includes the basic elements of the opportunity. Developing the initial scenario, one should be familiar with the user's needs and requirements. Such scenario should answer the following questions:

- Who is the end consumer, user?
- What are his/her needs?
- Where does his/her need come from?
- How is the task or the need currently met and developed?
- When is it taking place?

It should be taken into account that the iterative process is taking place between the scenario and the process of detecting the needs, which leads to a clearer vision and definition of the problem. This way, a particular problem has been defined. What follows is the standard design process.

3 The example of a stable manure spreader

3.1 Application of the method

An example will be used in order to show the example of searching for a new product. A company produces stable manure spreaders with the capacities ranging from 2700 kg to 20.000 kg. In cooperation between our LECAD laboratory and the company, a mixed group was established and it started the process of finding a new product - a radical innovation. This was also our final objective. Due to the cooperation between the laboratory and the company, the extent of knowledge was wide, which contributed crucially to the problem recognition.

Only some elements of the process of searching for an opportunity will be emphasized. Market definition of activity is very important. It was rather easy in our case as the company produces manure spreaders only. Figure 7 shows the difference between product definition of activities and market definition of activities. The latter is also the basic function of the product range in another sense. Thus, a broader view in this area was ascertained and new possibilities to discover opportunities for a new product were created.

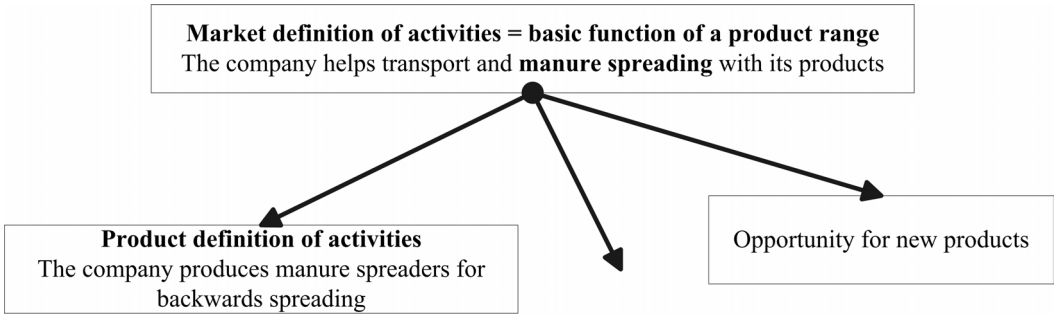

Figure 7: Defining the activities, areas

Using this method, one of the most important steps is step 2 and factors. The analysis of social factors has shown that many fatal accidents happen during manure spreading on steep slopes (15 deaths / 2 million citizens). Studies have shown that a lot of spreading on steep slopes is still done manually. A review of legislation has shown that the EU nitrate directive lays down the maximum permissible quantity of nitrate per hectare as well as time of fertilization. The trend in the spreading technology is to increase the range of spreading beyond 20 metres. These are only a few of the results of the factor analysis, however they led us to the sub area of spreading the manure in sloping areas. Several interviews were conducted and spreading itself was observed. The interview revealed unfulfilled needs, such as sideways spreading, spreading from roads and extending the range (beyond 20 metres). The interviewees expressed a wish for spreading from roads up the slope.

On the basis of interviews, polls and processes surveillance the opportunity definition was set:
There is an opportunity that manure spreading on the farms higher up in the mountains becomes safer, easier and faster.
Initial scenario:
Thomas is a farmer in his 40's. On 10 hectares, he rears 8 livestock units. His land is on a sloping terrain. The inclination of the terrain on 5 hectares of his land is under 35% and the inclination of the remaining 5 hectares is between 35 and 50%. He spreads 150 tonnes of manure each year.

3.2 Prototype – a radical innovation

Taking the iterative design process into consideration, a new spreading device was developed on the basis of a defined problem and scenario. The concept as well as the spreading technology is new. Designing the spreading device, we took account of the trend of longer spreading range and the need, discovered through interviews and work process surveillance. The spreading device is a radical innovation as it introduces new technology of manure spreading (It enables entirely new set of performance features.). It means longer ranges (up to 25 metres). Besides, the spreading device opened a new market as it enables long range or short range of sideways spreading as well as backwards spreading (Figure 8). It is possible to switch between both options by means of a hydraulic cylinder (Figure 8). The sideways spreader enables spreading from trails and roads. Due to a relatively long range (up to 25 m) it is possible to fertilize a considerable area, with minimum crossing of grassland. The spreading device is attached to the rear of the spreader, which means that the spreader's standard version remains the same and the vertical cylinders are still used for shredding and dispersion purposes. Only the rotor, attached perpendicularly to the direction of travel of the manure spreader, changes the direction of the manure spreading from backwards to sideways direction. The dispersion unit, which can be rotated around the rotor axle by means of hydraulic transfer, is located on the upper part of the additional spreading device and provides

for further shredding and directing of the manure. This is another advantage and another trend that expected to be a standard in future.

The device in the backwards spreading position

The device in the sideways spreading position

Figure 8 : The new spreading device, enabling backwards or sideways spreading

4 Conclusion

A directed search of opportunities for a new product, originating in a company, is a new approach to improving the number of innovations within a company and its development orientation. With the presented spreading device, a stable manure spreader producer will strengthen its position on the market, it will gain a competitive advantage over other producers and will become a leading company instead of a follower.

A radical innovation can only emerge when its environment is well defined. It is possible to define the environment if the limitations (company) are known and we have a survey within the limitations in all directions, based on the social, technologic, economic and legislative factors. We need to be aware that this is only possible with a wide extent of knowledge. In our case, we had the know-how from the company as well as the LECAD laboratory, which contributed to the radical innovation.

The use of the basic product range function provides us with a wide starting point for searching new opportunities. At the same time, the company's know-how and its productive capacities lead us towards the final objective. It is important to recognize the unfulfilled needs in the environment that a company can fulfil with its product. However, the product should meet the company's orientation and its productive capacities.

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