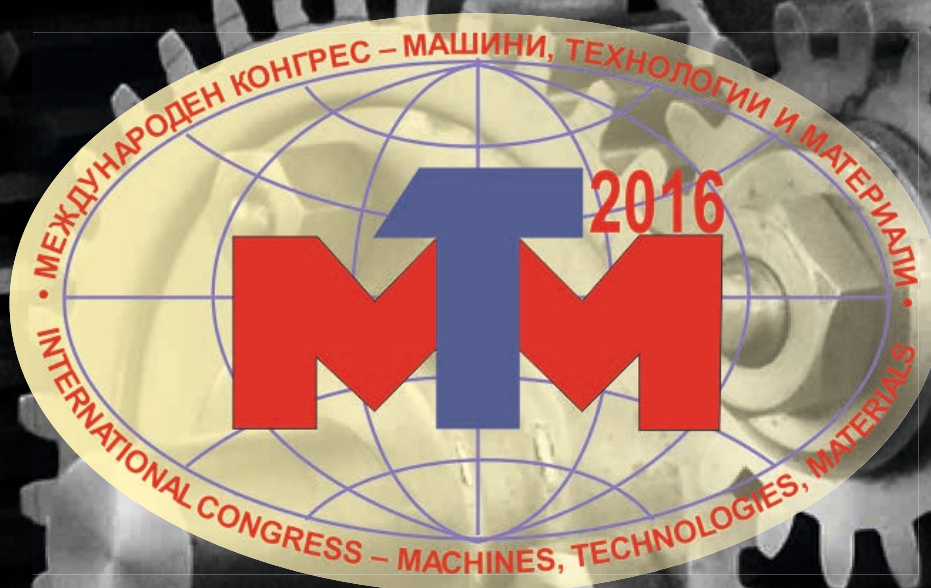


# **XIII INTERNATIONAL SCIENTIFIC CONGRESS SUMMER SESSION**

**MACHINES. TECHNOLOGIES. MATERIALS 2016**



# **PROCEEDINGS**

**VOL. 4  
INDUSTRIAL INFORMATICS  
INDUSTRIAL MANAGEMENT**



**ORGANIZER**

**SCIENTIFIC-TECHNICAL UNION OF MECHANICAL ENGINEERING**

**BULGARIA**

**ISSN 1310-3946**

**26 (212)**



# SCIENTIFIC PROCEEDINGS

*OF THE SCIENTIFIC TECHNICAL UNION  
OF MECHANICAL ENGINEERING*

**Year XXIV**

**Volume 26/212**

**SEPTEMBER 2016**

## **XIII INTERNATIONAL SCIENTIFIC CONGRESS**

# **MACHINES. TECHNOLOGIES. MATERIALS. 2016**

### **SUMMER SESSION**

**14–17.09.2016 VARNA, BULGARIA**

**VOLUME IV**

**SECTION “INDUSTRIAL INFORMATICS 2016”  
SECTION “INDUSTRIAL MANAGEMENT 2016”**

**ISSN 1310-3946**



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# SUMMARY OF INNOVATION MODELS ON A COMPANY LEVEL – CREATING A FRAMEWORK FOR AN INNOVATION MODEL THAT WILL INCREASE A COMPANY'S INNOVATION ACTIVITY

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**Abstract:** There are six known and generally accepted generations of innovation models. Innovation models transform from simple, linear models, to integrated and networking models that are dynamic and interactive. Each generation of innovation models is presented in this paper with their characteristics as well as drawbacks. The main goal of this paper is to show the transformation path of innovation models and create a framework for a new innovation model on a company level, that could be used by companies to increase their innovative activity and performance. Innovation models define the innovation process and its phases. The framework for the new innovation model includes feedback that was lacking in the first and the second generation of innovation models, but is included in the other generations. It also includes integrated and networking activities which are a characteristic of the third and fourth generation of innovation models. Another component of the model is the usage of information and communications technology (ICT) to facilitate the process of innovation, which is one of the characteristic of the fifth generation of innovation models. It uses a process approach and is based on the open innovation model, which is the signature model from the sixth generation of innovation models and best represents the complex system and characteristic of innovation. The model is supposed to help companies generate innovative ideas and select them through a predetermined process with four main components that act as control points. The purpose of this model is to create a continuous culture for innovation and to set up official procedures. These will help companies to accomplish their innovative ideas and activities.

**Keywords:** INNOVATION, INNOVATION MODELS, OPEN INNOVATION, TECHNOLOGICAL INNOVATION, INNOVATION PROCESS.

## 1. Introduction

Innovation models are being used so that companies can manage their innovation processes which have evolved tremendously in the last few decades of the XX century. Companies can adopt an existing model, or they can create their own [1]. By having an innovation model, it is easier to manage the order in which innovation activities happen. It also helps with determining the resources and responsibilities for every stage of the process as well as deciding which methods and tools companies will use. Innovation as a process has a very dynamic character, and the models of innovation have transformed throughout the years. Innovation models can be on a company level or a national level (such as National Innovation Systems – NIS) and can also be adopted and used by a region, an economy etc. In this paper we will focus on the company level innovation models. Based on the main characteristics of the different generations of innovation models, we are suggesting a framework for an innovation model that can be highly applicable to all company sizes, whose main goal is to increase the innovation activity and increase a company's innovation performance.

## 2. Innovation models and their characteristics

Currently there are six known generations of innovation models, although a seventh generation of innovation models is mentioned by Kotsemir et al., that has “emerged”, but is “not formed yet” [2]. Rothwell's five generations of innovation models give a historical perspective of innovations management that shows how innovation models have transformed from linear to complex interactive models [3]. The approach to innovation management Rothwell gives in his classification relates to the evolution of organizations, the strategies of innovations management under various socio-economic and political circumstances and doesn't include the substantive development of the innovation models themselves [4]. Rothwell's typology is based on models of innovation on a company level.

Another typology of innovation models is presented by Marinova and Phillimore where they present six generations of innovation models [5] and for their classification they use

technological models that apply to the overall economy, plus they give a theoretical background of the generations of the innovation models, as well as their positive and negative sides [6].

**Table 1** shows the generations of innovation models by Rothwell [7] and Marinova & Phillimore [8].

**Table 1.** Generations of innovation models, author's adaptation of Rothwell (1992) and Marinova & Phillimore (2003)

Gene-ration	Period	Rothwell	Marinova & Phillimore
1	1950's – mid 1960's	Technology push model	The black box model
2	Mid 1960's – early 1970's	Market pull model	Linear models (technology push – need pull)
3	Early 1970's – mid 1980's	Interactive or Coupling model	Interactive models (coupling and integrated models)
4	Early 1980's – early 1990's	Integrated innovation process (parallel development)	Models of innovation systems (networks and national innovations system)
5	1990's	SIN (Systems integration and Networking Model)	Evolutionary models
6			Innovation milieu

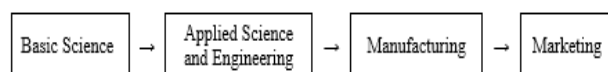
The model of *Innovation milieu* is considered to be a networking model that applies on a national level. On a company level though, the model of *Open Innovation* is the sixth generation model of innovation [9]. The father of the *open innovation model* is Henry W. Chesbrough, who has introduced this concept stating that innovation has become an increasingly open process thanks to a growing division of labor [10]. Therefore, we will present the six generations of models and their main phases and characteristics, as well as their drawbacks.

We will start with the *first generation of innovation models* and the famous *linear model of innovation (technology push)*. The main phases of this type of models are: 1) basic science/fundamental

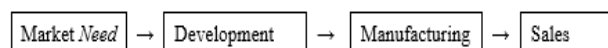
research; 2) design and engineering; 3) manufacturing; 4) marketing and 5) sales [11,12]. This is a period where a lot of resources were put towards the R&D in companies, because it was believed that the more R&D is done, then more new products will be out. This pushed innovations forward, but did not give enough attention to the transformation process of existing products [13] or the needs of the market place and the consumers [14].

The *second generation of innovation models* is not much different from the first one. Both lack feedback loops, but the second one recognizes the fact that including the market/consumer needs will help drive performance and will be a source of ideas for new and better products/services [15]. Therefore, the second generation linear model of innovation is called the *linear model of innovation (market pull/demand pull)*. Both models are shown in **Figure 1** and these are the technology push and need pull models suggested by Rothwell.

“Technology-push” model:

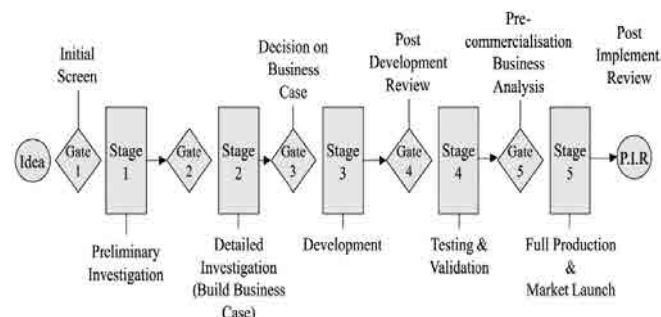


“Need-pull” model:



**Fig. 1.** Rothwell’s Diagram (source: Godin, 2013)

The first and second generation of innovation models have predetermined phases with a consecutive nature (as shown on **Figure 1**) and are both still being used today, with minor modifications such as adding control elements between each phase to approve the transitioning from one phase to another, and also to better the decision process just like the *stage-gate model*. This model was predominantly used by NASA in the 1960’s while trying to find creative innovative ideas to send a man on the Moon. This model, further simplified and suggested by Cooper [16] consists of five relevant phases or stages (as shown on **Figure 2**), and the added controlling elements here are the *gates* positioned after each phase. Their function is to follow the fulfillment of strict and predetermined criteria before we move onto the next stage [17]. Many other companies have adopted and used, or are still using, this model [18].

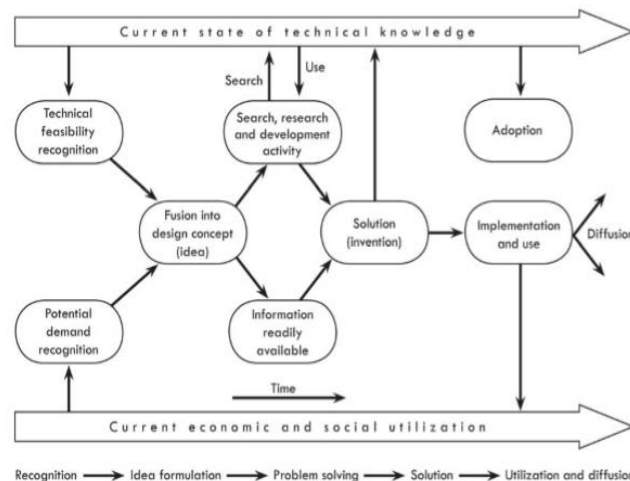


**Fig. 2.** Cooper’s Stage Gate Model (Source: Cooper, 1994)

The *third generation of innovation models* differ from the first and second significantly. These models are given the name *Interactive models* as a result of recognizing the interaction between elements in the innovation process which is a key for innovation’s success. The technology push and market pull models are “coupled” in this generation which implies suppliers and customers to be closely “coupled” in product development teams [19]. The models include interaction and feedback between phases such as the

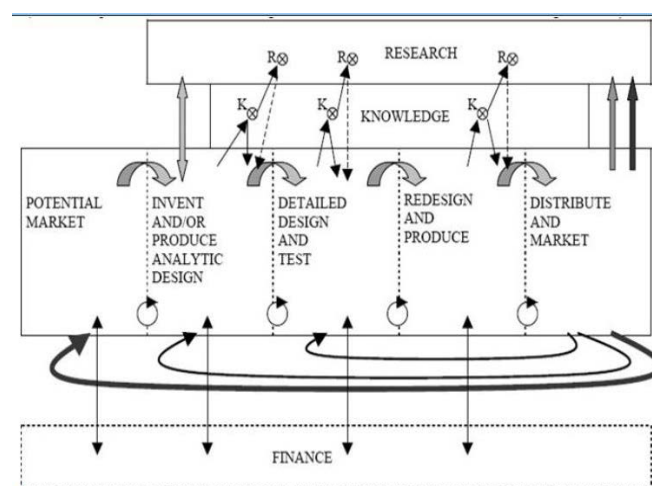
marketing research and the other elements in the linear process [20], but could not differentiate the need from the demand. *The Coupling model of Mayers & Marquis* (as shown in **Figure 3** [21]) is a third generation innovation model, where the innovation activities are divided in subcategories under each phase, and all of them are interacting [22].

The *fourth generation of innovation models* corresponds to the Japanese perception of the innovation process and it was the answer to the need of replacing the linear model with a different model that can reflect the complex innovation process [23]. The models from this generation consist of the basic stages of the linear models of innovations, enriched by many feedback loops and interaction between the stages, as well as a validation of the knowledge gained in the innovation process [24].



**Fig. 3.** The Myers and Marquis Coupling Model from 1969 (source Godin, 2013)

These models are also functionally integrated innovation models and they achieved integrating the suppliers, customers and partners in the development process [25]. On **Figure 4** is the *Chain-Linked Model*, developed by Rosenberg and Kline (1986).



**Fig. 4.** The Chain-Linked Model of Innovation (Rosenberg and Kline, 1986) Source: [www.uis.unesco.org](http://www.uis.unesco.org).

After seeing a trend of cutting down on R&D costs companies had to network and find different ways to proceed with their innovative activities [26]. Information systems became the next big thing and started being incorporated into the companies work, especially in process automation and in expediting the communications inside a company’s network [27]. Therefore, the different activities within the innovation process became even more integrated and could occur simultaneously, with feedback loops. We

also notice a trend of overlapping functions. This is when the *fifth generation of innovation models* appeared. Rothwell's *SIN (Systems Integration and Networking)* model as a fifth generation innovation model incorporates the higher integration inside companies as well as with the outside entities such as suppliers, consumers, universities and authorities [28].

Introduced by Chesbrough, *The Open Innovation Model* (Figure 5) underlines idea management not just within the organizations, but also with other organizations. R&D is being done by outside partners, if it is not possible to be handled by the company itself, and ideas can occur while developing a new product/service which can change the course of the process. This model promotes using outside knowledge, such as suppliers, competition, entrepreneurs, scientists etc. [29].

The open innovation process can be 1) the *outside in process*; 2) the *inside out process*; and 3) the *coupling process* [30] and innovative ideas are introduced by outside sources such as universities, research centers, suppliers, competition, government bodies and consumers [31]. There are four main phases of this innovation model: 1) *research*; 2) *development*; 3) *manufacturing*; and 4) *marketing*, coupled with other processes and entities with an interactive nature [36]. R&D in this model is taken over by publicly funded research centers or universities where ideas are chosen through a highly competitive selection process which promotes transparency of innovation activities.

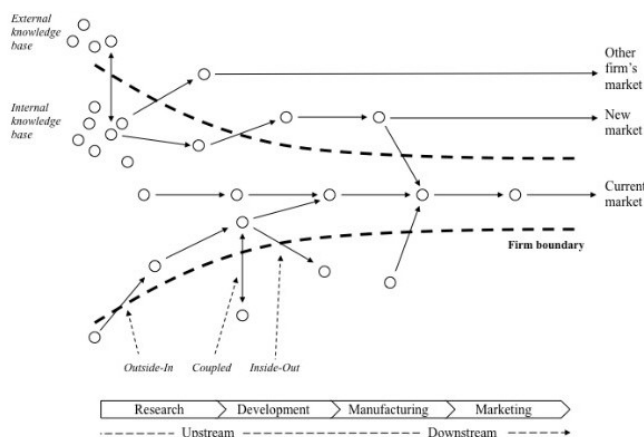


Fig. 5. The Open Innovation Model (Chesbrough, 2014)

Such models have been implemented in large companies, but there are also findings that open innovation models have been used in SME's as well, primarily for market related motives, such as meeting customer demands and keeping up with competitors where the biggest challenges lie in organizational and cultural issues as a consequence from dealing with increased external contacts [32].

### 3. Discussion

What we have learned from the six generations of innovation models is that a good innovation model has to have *predetermined phases*, *feedback loops*, large capability for *interaction* and *integration*, but also to be *knowledge based*, able to use outside knowledge, endorse knowledge gain and maintain the knowledge level in the company through achieving a continuous learning culture. Because the feedback loops were lacking in the first and second generation of innovation models, and customer's feedback is an essential element of innovation, we consider them as a part of every stage of the innovation process. Another element for a successful innovation process is *networking*, which will help companies of all sizes, not just the large ones that can afford their own R&D, to be able to innovate and enter new markets. This will also help in the effort of *knowing the competition* and keep in tune with the technological advances. *Identifying new sources* of ideas is crucial for generating innovative ideas, that has been used for the

first time in the second generation of innovation models, where market pull became the main source of ideas.

Planning a *reliable and safe funneling of ideas* and their distribution will encourage innovative minds to take part of the process and share their ideas and knowledge. The *selection process* of innovative ideas should be done by strict criteria and very carefully, and the model should be able to know whether it is *the right time* for introducing a certain innovation on the market or not. This should be enabled by using *marketing, legal, economical and development component* as a part of the process, where the marketing component can determine whether an idea can be marketable or not, the legal component will deal with the patenting potential of the innovative idea that can be an additional source of income and potential success, the economic component will be able to say how economically feasible the new idea is and whether we can use outside R&D facilities or other entities to help in the process; and the development component the actual R&D of the idea before bringing it to market and getting to the *realization and diffusion* stages.

### 4. Conclusion

The transformation process of the innovation models show that innovation is of a changing nature and very complexed. In order to suggest a new model that can help companies innovate more in regions with a low innovation activity trend, we need to take in consideration that no innovation can happen if the *company culture* doesn't enable this itself. For companies to become more innovative, they need to be *ready for change* and to have set up mechanisms that will support the process.

We can state that in order to have an innovation model that could be widely applicable to different types and sizes of companies, the model itself should be of a simple and maybe with a certain linear character, but with enough details that are going to clearly describe the innovation process. The main phases of the innovation model should be marketing, legal, economic, development, realization and diffusion phase, integrated with feedback loops, and potentially modified with other predetermined phases. It should include measures and tools for evaluation of feedback. The model should also be knowledge based, easy to adapt to a networking environment, handle interaction, know the competition and easily identify new sources of ideas that will be funneled through a predetermined channel. Achieving a continuous learning culture should be an integrated part of the model. As a beginning of the innovation process we can say that generation of ideas is the most important part, as well as planning a reliable and safe funneling and distribution of the same ideas.

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