



INTERNATIONAL CONFERENCE ON INNOVATIVE TECHNOLOGIES

# IN-TECH2016

PRAGUE, CZECH REPUBLIC **6. - 8. 9. 2016**



Organized by:  
**World Association for  
Innovative Technologies**

# Proceedings



International Conference on Innovative Technologies, IN-TECH 2016,  
Prague, 6. - 8. 9. 2016



## International Conference on Innovative Technologies

# IN-TECH 2016

Prague

## Proceedings



# IN-TECH 2016

Proceedings of International Conference on Innovative Technologies



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**Publisher:** Faculty of Engineering University of Rijeka

**Printed by:** TISK AS, s.r.o., Jaroměř, Czech Republic

Printed in 100 copies.

**IN-TECH 2016** International Conference on Innovative Technologies

runs from 6. 9. 2016 to 8. 9. 2016 in Prague, Czech Republic.

E-mail: [info@in-tech.info](mailto:info@in-tech.info)

URL: <http://www.in-tech.info>

**ISSN 1849-0662**



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# GENERATIONS OF INNOVATION MODELS AND THEIR CHARACTERISTICS – TOWARDS CREATING A NEW INNOVATION MODEL

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**Keywords:** Innovation; Innovation Models; Open Innovation; Technological Innovation; Innovation Process

**Abstract:** Innovation is a process that consists of phases and activities and requires resources and knowledge. Innovation models define the innovation process. Innovation models are mentioned in the literature reviews with different names such as work frame, paradigm, sequence, process, etc. In this paper we give a summary of six generations of innovation models in order to show their transformation from linear models to models of open innovation. Each generation of innovation models has a specific character. Independent of the chronology and typology that has been used to separate models into generations, the focus can be put on social, educational and organizational innovation on one side, and technological innovation on the other side. We focus on the company level innovation models. The first and second generation innovation models are very simple and they are predictors of innovation models of the third generation which confirm that innovation can occur in different places throughout the process. The fourth generation focuses on product and process integration and the fifth generation models accent system integration and networking. The sixth generation of innovation models is characterized by dynamism, integration, systematic approach and a high level of interactivity.

## Introduction

Innovation models are not news in the modern economy. They have been used to help companies achieve their peak of innovation and success. The innovation process has evolved tremendously in the last few decades of the XX century, beginning with linear and sequential models. Large corporations create their own innovation models in order to manage the innovation process [1]. Companies need to create innovation models because it will help them manage the order in which innovation activities are happening, define resources and responsibilities, it will help in determining which methods and tools they will use etc. Innovation models are mentioned in the literature reviews from the late 1960's and early 1970's with different names such as *work frame*, *paradigm*, *sequence*, *process*, and very rarely the word *model* is being used. After the 1970's authors tend to use the word *model* in order to describe the innovation process flow or framework for innovation activities and we can notice the words *models of change*, *models of invention*, *models of creativity*, etc. [2]. The popular *linear innovation model* is referred in the earlier literature more as a *linear sequence*, and not so much as a *linear model*.

## Types of innovation and their classification

All classification of innovation models in literature represent terms that explain where something new, better or different occurs, depending on the degree of detail. Innovation can occur at any level of a company and by any employee. Therefore, we made a list of different types of innovation that we simplified and will use for further reference and analysis. Innovation may be classified as: a) *according to object/subject of innovation* (innovation of a product/process/service/production method or work placement to new markets, sources of supply, ways of organizing work); b) *according to how big the innovation is and to whom it would be considered an innovation* (Innovation for the firm, innovation for the market and sector, news for the world etc.); c) *according to target/target groups of innovations* (disruptive and maintained innovation); d) *according to the openness of the innovation* (open and closed innovation); e) *according to the impact of the innovation on the overall business strategy* (innovation that creates value for customers, for the business and innovations that are trying to reach the purchasing power of consumers); f) *according to the frequency of innovations* (continuous and non-consistent innovation); g) *according to the functionality to which innovations relate* (modular and architectural innovation) [3,4,5,6]. Because of the many different types and classifications of innovation, this research paper will continue to focus on three classifications of innovation and their types: 1) *object of innovation* (innovation of products/goods/services, methods of production, business processes, marketing innovation, technological innovation); 2) *the innovation size* (radical, incremental and disruptive innovation); and 3) *place of innovation activity and where it occurs* (open and closed innovation). We narrowed the classifications mostly because many companies are not able to recognize the type and/or classification of innovations they have.

## Generations of innovation models and their characteristics

Innovation as a process has a very dynamic characteristic, and that is why the models of innovations have transformed throughout the years. Different researchers give their own typologies of innovation models that mainly use the chronology of Rothwell's five generations of innovation models. Rothwell gives a historical perspective of innovations management that shows how innovation models have transformed from linear to complex interactive models [7]. The approach to innovation management he gives in his classification relates to the evolution of organizations, the strategies of innovations management under various socio-economic and political circumstances and not the substantive development of the innovation models themselves [8]. Another typology of innovation models is presented by Marinova and Phillimore where they present six generations of innovation models [9]. They use technological models that apply to the overall economy, and give a theoretical background of the generations of the innovation models and their positive sides as well as their faults [10]. Rothwell's typology is based on company's models of innovation. Based on the chronology and typology of Rothwell, Kotsemir

and Meissner suggest six generations of innovation models, where they add the *open innovation model* as a sixth generation model [11]. Table 1 shows the generations of innovation models by Rothwell [12], Marinova and Phillimore [13] and Kotsemir and Meissner (2013) [14].

Table 1. Generations of innovation models, author's adaptation of Rothwell (1992), Marinova and Phillimore (2003) and Kotsemir and Meissner (2013)

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

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 [15].

### First generation of innovation models

The *linear model of innovation* represents the first generation of innovation models. It is a simple model, with no feedback loops, with predetermined phases and of a consecutive nature. The model was widely used after World War II, and has been developed in three phases such as: 1) phase of idealization of pure science; 2) applied science and its connection to pure science; and 3) development phase [16]. Therefore, the main phases of the first generation linear model of innovation (*technology push*) are: 1) *basic science*; 2) *design and engineering*; 3) *manufacturing*; 4) *marketing* and 5) *sales* [17, 18]. Emphasis was put on R&D in companies, where it was believed that the more R&D is done, then more new products will be out. This did push innovations forward, but did not give enough attention to the transformation process [19] or the needs of the market place and the consumers [20]. Such innovation model can and is still being used by some companies mainly for defining the process of product and service development, and collaboration with suppliers. All but the marketing phase are existent, and it doesn't take in consideration the customer's needs. An additional control element is added between each phase, to approve the transition from one phase to another. It is called the first generation innovation model from the USA [21].

### Second generation of innovation models

In this generation, emphasis was put on the market and consumer needs. That is why the linear model of the second generation was given the name *market pull/demand pull/need pull*. The difference between this model and the previous one is that this model sees the consumer need as a source of ideas for the marketplace [22]. One of the most popular models of the second generation of innovation models in the USA is the *stage-gate model*, 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 [23] consists of five relevant phases or stages (Fig. 1), and decisions (happen at *the gates* which function as a controlling element) positioned after each phase in order to follow the fulfillment of strict and predetermined criteria before we move onto the next stage [24]. Research shows that this type of model has been adopted and used by many other companies as well [25].

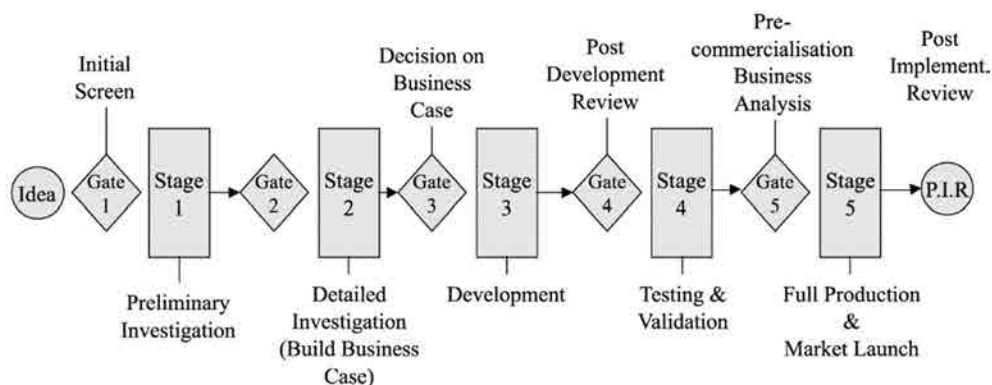


Fig. 1 Cooper's Stage Gate Model (Source: Cooper, 1994)

### Third generation of innovation models

This generation of innovation models treats innovation as a combination of technology pushes and market pulls. The models include interaction and feedback [26]. Its representative is the *Interactive model of innovation* or *Coupling model* (for ex. *The Coupling model of Myers & Marqis*), where the innovation activities are divided in subcategories under each phase, and all of them are interacting [27]. According to Rothwell and Zegveld (1965), the whole scheme of the innovation process can be pictured as a complex network of

communication paths, inside an organization as well as outside of it, connecting the different inter organization functions and the company with the broad scientific and technological environment and the market. According to Mowery and Rosenberg (1991) these models could not differentiate the need from the demand.

#### Fourth generation of innovation models

The fourth generation of innovation models has the *Chain-Linked Model* as its representative, developed by Rosenberg and Kline (1986). 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 [28]. It 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 [29].

#### Fifth generation of innovation models

Rothwell's *SIN (Systems Integration and Networking)* model is a model of the fifth generation of innovation models. It incorporates the higher integration inside companies as well as with the outside entities such as suppliers, consumers, universities and authorities [30]. The different activities within the innovation process are integrated and can occur simultaneously, with feedback loops. Functions can overlap, and innovation happens inside the company. The need for such a model started since there was a trend of cutting down on R&D costs, so companies had to network and find different ways to run their innovative activities [31]. Information systems became the next big thing and started being incorporated into company's work, especially in process automation and in expediting the communications inside a company's network [32].

#### Sixth generation of innovation models

The *Open Innovation Model* (Fig. 2 The Open Innovation Model [33]) is created and introduced by Chesbrough and underlines idea management not just within the organizations, but also with other organizations. This model promotes using outside knowledge, such as suppliers, competition, entrepreneurs, scientists etc. [34]. R&D is being done by outside partners, and ideas can occur while developing a new product/service and can change the course of the process. The main sources of the innovative ideas are outside sources such as universities, research centers, suppliers, competition, government bodies and consumers [35]. The main four phases of this innovation model are: 1) research; 2) development; 3) manufacturing; and 4) marketing, but they are coupled with other processes and entities and are of an interactive nature [36]. The *Open Innovation Model* puts its emphasis on reducing the cost for R&D which will be taken over by publicly funded research centers or universities, and ideas will be chosen through a highly competitive selection process. It also promotes transparency as a key for a successful innovation, as well as generating a large amount of innovative ideas. 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 with dealing with increased external contacts [37]. The open innovation process can be 1) the *outside in process*; 2) the *inside out process*; and 3) the *coupling process* [38].

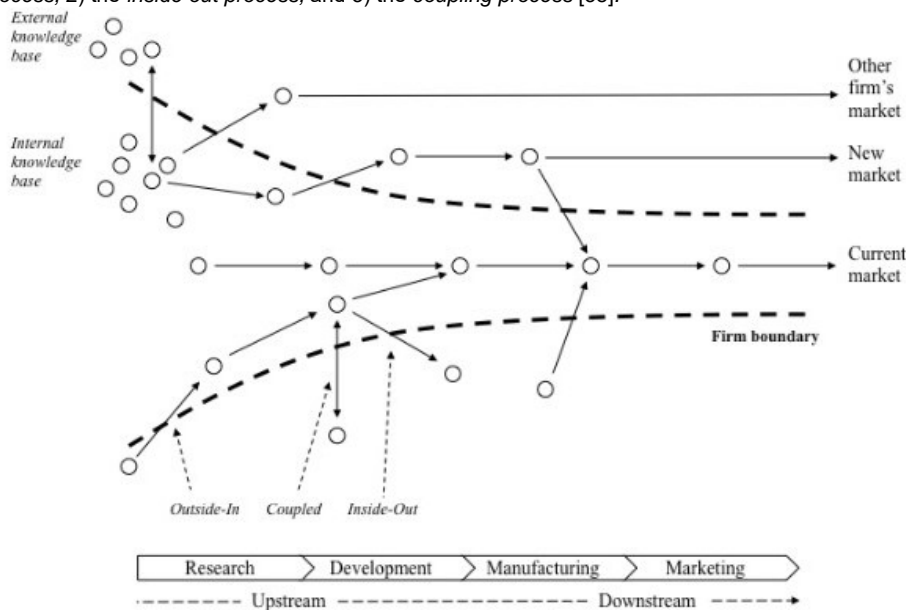


Fig. 2 The Open Innovation Model (Chesbrough, 2014)

#### Conclusion

From the above mentioned we can conclude that the innovation model that could be widely applicable to different types and sizes of companies, should be of a simple nature, easy to use with enough details that will be able to clearly describe the innovation process. A set of measures should be predetermined and tools for evaluation of the feedback received by customers and suppliers. A focus should be put on knowledge gain and on maintaining the knowledge level at the company, as well as achieving a continuous learning culture. Networking is one of the best ways for a company to increase its innovation capability and performance. Companies need to determine what drives their innovations and to take action. 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. The next stage should be the selection stage, where companies can determine whether their ideas have the potential for realization or not. Four components should be taken in consideration: marketing, legal, economical and developmental component. These can be used as controlling elements in order to determine whether a company should proceed with the next stage or not. Next stages for continuing of the innovation process are planning



and realization, diffusion and marketing, and of course the feedback (from customers, suppliers and environment) which is a “must have” in innovation models.

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