ISSN 2056-5992

# TECHNOLOGY LEAPS: DEFINITION AND FRAMEWORK FOR ASSESSING THE POTENTIAL OF TECHNOLOGY LEAPS

**GUENTHER SCHUH**
Fraunhofer Institute for
Production Technology IPT
**GERMANY**

**DAOJING GUO**
Fraunhofer Institute for
Production Technology IPT
**GERMANY**

## ABSTRACT

Technologies, i.e. product, production and material technologies represent a crucial competitive factor for technology oriented companies. The decision, which technologies should be used for the manufacturing of which products is one central task of a company´s technology management. In times of gathering pace of change, shortened technology and innovation cycles, more complex technology chains and new, advanced information technology, it is a main task for many companies to detect trends in time, to asses them regarding its relevance and to derive meaningful measures for the company. Those measures can be concrete steps, which refer to the substitution of an established technology by an innovative, new technology with considerably improved technological performance parameters. Companies however can initialize trends actively by developing innovations respectively technology leaps to position themselves in the market as a pioneer. A holistic and applicable method for assessing the potential of new, innovative technologies, i.e. technology leaps against company-specific backgrounds, is required especially considering the relatively high uncertainties but also possible high return on technology leaps. The potential of a technology is determined by its expected individual performance in the future. Therefore, a consistent understanding of technology leaps and their main characteristics are necessary. Further a method for the assessment of a technology leap´s potential is required.
This paper introduces a new approach for characterizing and classifying technology leaps. First, a literature review of existing works regarding technology leaps and assessment is given and deficits as well as demand are derived. In a next step a characterization and classification of technology leaps will be introduced, highlighting the main characteristics of technology leaps. In a final step a rough framework is presented for a quantitative assessment of technology leaps' potential.

**Keywords:** Technology leaps, constituent characteristics, technology and potential assessment.

## INTRODUCTION

Technology leaps, radical technological changes or technology shocks all describe the same phenomenon, when a new technology substitutes an existing technology or an existing technology experience a fundamental technology improvement. These improvements can be both process and product related [1], [2]. In addition to these prominent terminologies many other synonymous and similar formulations describe the same phenomenon. In this article the word technology leap will be used for the current scope of consideration. Until today many authors have contributed meaningful work to this area of research, but still there is no consistent understanding or unambiguous definition of the term "technology leap" or synonymous formulations. Neither in science nor in practice are the constituent characteristics of technology leaps known. Without a clear understanding of the main characteristics of technology leaps it is very difficult for companies to assess the potential of technology leaps and derive concrete measures for their companies. Possible measures are the investment in or the refusal of a new technology. Technology leaps are characterized by other aspects than for example incremental technology developments or disruptive innovations. Incremental technology developments are marginally enhanced technologies with relatively low technology and market risk and serving the existing customer segment. Disruptive innovations primarily have a high market impact by applying established technologies into a new application context [3]. Technology leaps are usually connected with higher risks than incremental technology developments, but deliver also a higher return on technology if being able to establish itself in the market etc. When comparing technology leaps to disruptive innovations it can be noted, that technology leaps are characterized by a major technological progress, whereas disruptive innovations can also be created by using established technologies. All these characteristics which distinguish technology leaps need to be considered when assessing its potential for a company.

Based on a clear definition and characterization of technology leaps, companies need to assess the potential of technology leaps against their company-specific background. Often qualitative assessments are being conducted in order to decide whether to invest in a new innovative technology or not. But qualitative assessments are often more vague and subjective than quantitative assessment methods [4]. So, in this paper we also want to introduce a rough framework for quantitatively assessing the potential of technology leaps.

| **Incremental technology development** | *criteria* | **Technology leap** |
|---|---|---|
| Market pull | **Origin** | Technology push |
| Low | **Market risk** | High |
| Low | **Technology risk** | High |
| Low | **Return on technology** | High |
| Short-term | **Timescale** | Long-term |
| Low | **Technological progress** | High |

**Figure 1 – Comparison between incremental technology development and technology leaps**

## LITERATURE REVIEW: TECHNOLOGY LEAPS AND TECHNOLOGY ASSESSMENT APPROACHES

As mentioned before both in practice and literature a variety of terms exists to describe “technology leaps”. Frequently used other terms are “radical technologies”, “technological changes”, “disruptive technologies”, “breakthrough technologies”, “discontinuous technologies” etc. [5]. In order to illustrate the term “technology leap” the concept of S-curves after TWISS can be used. This S-curve visualizes the technological progress over time, see figure 1. It describes the observation that the performance of a technology usually improves over time. But after a specific amount of time the increase of technology performance gets less and closer to an asymptote [6]. Mostly, it is being spoken of a technology change, if a switch from one S-curve to another with higher performance level or potential occurs. Most technology changes occur by the time when an innovative technology is significantly more advanced in comparison to the established technology, e.g. by substantially improved technological performances. Furthermore a discontinuous technology development can be registered, so that the S-curve´s course makes a "leap". This phenomenon is observable when e.g. a technology gets substantially improved by integrating another complementary technology (e.g. laser-hybrid-welding).

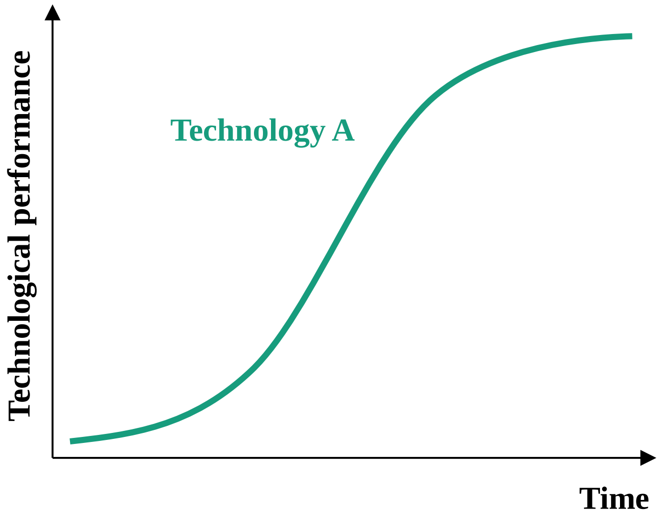


**Figure 2 - Concept of S-Curves according to TWISS [6]**

In the following section different approaches are described for defining technology leaps or related relevant works.

## Approaches for characterizing technology leaps

The author KALBACH [3] used the two dimensions "technological progress" and "market impact" (e.g. clients, competitors, suppliers) for developing innovation types (see Figure 2). Incremental innovations are characterized by marginal technological progress and relatively low market impact. Incremental innovations provide the possibility of a short-term improvement of its entrepreneurial market position for an existing application context. An example for that is the product change from iPhone 5 to iPhone 6. Here, the main product technologies, production technologies as well as architecture or main functions did not change. The new iPhone 6 simply had more features or enhanced functions. "Breakthrough innovations" can be described by a significant technological progress and a relative low market impact (e.g. change from tube television to LCD TV). Next, disruptive innovations exercise high market impact at low technological progress. This occurs especially because of the development of innovative business models, fields of application and combination of established technologies with each other, as well as addressing new client segments. As an example the digital media player "iTunes" can be mentioned which commercialized the use of mp3 files. In this case the existing mp3 technology has been applied, but addressing a larger customer segment and taking market shares from incumbent players such as Sony Music (music company). "Game changer" innovations in the end are characterized both by a significant technological progress and a high market impact, e.g. regarding perceived value of technology respectively of product by the client (example: first launch of smartphones). Going beyond KALBACH's definition of "breakthrough" and "game changer" innovations they represent technology leaps in this paper's understanding, as they are characterized by a high technological progress.

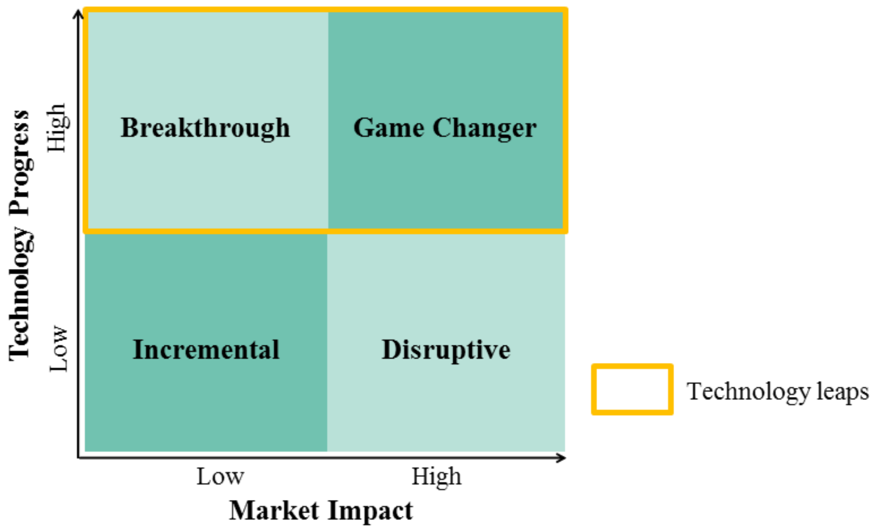


**Figure 3 - Classification of different types and technology leaps [3]**

In "The innovator´s dilemma" CHRISTENSEN differentiates between sustaining and disruptive technologies. Sustaining technologies are characterized by improved product performances. Whereas disruptive technologies feature a different value proposition than had been available in the market before. Thus, disruptive technologies often address another or new market segments than the older technologies. Initially, disruptive technologies are worse in performance and below main customer requirements compared to the established technology. "They have other features that a few fringe – and generally new – customers value" [5],[ 7]. But via continuous innovation the disruptive technology´s performance gets improved and accepted by the established customer segment. CHRISTENSEN mainly focuses on product innovation and less on process innovation. CHRISTENSEN and BOWER employ the value proposition/ product performance as key aspects for characterizing technological change.

ANDERSON and TUSHMAN differentiate major technological changes in processes and products. They articulate the view that product discontinuities lead to the emergence of new product families (e.g. automobiles, airlines), product substitution (e.g. diesel vs. steam locomotives) or fundamental product enhancements (e.g. jets vs. turbojets). With regard to processes, discontinuities can lead to process substitution (e.g. thermal vs. catalytic cracking in crude oil refining) or process innovations which radically improve industry-specific performance (e.g. increase of cost-efficiency through the introduction of mini steel mills) [TUSH86]. ANDERSON and TUSHMAN, as well as many other authors, have classified technological change or innovation into incremental, continuous and basic, radical discontinuous technological changes. The key aspect for characterizing technological change is its technological advance. Incremental technological progress can be described as a continuous, cumulative process stimulated by the potential of economic return until the occurrence of a major technological advance. Basic, radical discontinuous technological changes constitute advances in technologies which are superior in scale, efficiency or design in comparison to older technologies [1], [2], [8], [9].

HENDERSON distinguishes incremental and radical innovation and uses the dimension of product properties in order to differentiate between these two types [10]. The dimension product properties can be divided into two sub-dimensions “change of correlation between components” and “change of core concepts”. HENDERSON has developed a matrix containing four fields: radical, architectural, modular and incremental innovations. Incremental and radical technological change or innovation constitutes the extreme points along the diagonal of the two dimensions. After HENDERSON radical innovation creates a new design which expresses itself in new core concepts and changed links between components and concepts. Incremental innovation improves an existing design without changing the core concept and its links. Modular innovation is characterized by changed core concepts but similar or same product architecture. Architectural innovation changes the basic design but does not change the core concepts [10].

All in all it can be summarized that KALBACH employs technological progress and market impact whereas CHRISTENSEN and BOWER define the value proposition/ product performance as main aspects for characterizing technology leaps. ANDERSON and TUSHMAN differentiate between incremental, continuous and basic, radical discontinuous technological changes. The key aspect for characterizing technology leaps is its technological advance. HENDERSON and CLARK apply product properties as aspects for characterizing technological change [1], [2], [3], [5], [7], [8], [9], [10], [11], [12], [13].

| **Key aspect** / **Authors** | Technological advance | Customer, relationship, competence | Product properties | Value chain | Value proposition/ product performance |
|---|---|---|---|---|---|
| Anderson Tushman ’86,’90<br>Baba ’89<br>Glasmeier ’91<br>Ehrnberg, Jacobsson ’97 | *Incremental, continuous vs. basic, radical, discontinuous* | | ◐ | | |
| Abernathy, Clark ‘85 | ◐ | *Niche, regular, archi-tectual, revolutionary* | ◐ | ◐ | ◐ |
| Henderson, Clark ‘90 | ● | | *Incremental, modular, architectural, radical* | ● | |
| Christensen, Bower ’95,’96,‘97 | ● | | ● | | *Sustaining vs. disruptive* |

Legend: ● = Authors who included this aspect ◐ = Authors who partially included this aspect

**Figure 4 - Key aspects to characterize types of technological change [1], [2], [5], [7], [8], [9], [10], [11], [12], [13]**

The mentioned authors have reasonably characterized types of technological change. What is striking is that many authors do not clearly distinguish between technology and innovation leaps. Thus, they contribute to the heterogeneous definitions of technology leaps and similar terms. One of the few authors who made a distinction between technology and innovation is CHRISTENSEN. He first focused on “disruptive technologies” when publishing his work

“The innovator´s dilemma”. Then he extended his field of investigation and emphasized “disruptive innovations”. CHRISTENSEN stated that only considering technologies might be too limiting and extended his scope of consideration with products and business models [5]. In general, technologies include “knowledge, information and abilities for solving technological problems as well as plants and processes for practical implementation of scientific knowledge” [14]. Therefore, technologies constitute solutions which are only valuable when they are being put in a specific area of application. Only by connecting technologies with specific applications the potential of technologies is recognizable and measurable [14].

Often the terms technologies and innovations are being used synonymously, although there is a difference between these two terms. The main difference is that innovations are not limited to technological solutions but also include organizational improvements or novelties such as business model innovations, whereas technologies are more concentrated on technological solutions. In conclusion technologies and innovations have an overlap since both are related to technological aspects. But innovations also consider organizational aspects. (A technological leap constitutes a technological change. A new business model development constitutes an innovation but not necessarily a technological innovation.) In this paper the focus lies on the technological aspect of innovation. New business models or services are not priority of this work, which is simultaneously a major difference between the works of the authors mentioned before and this paper.

**Technology assessment approaches**

In the following some significant technology and potential assessment approaches are being presented, which support the development of a framework for assessing the potential of technology leaps. PARK and PARK developed a technology measurement model based on the determination of monetary value of a technology, i.e. its predicted future income [15]. PARK and PARK developed three modules as assessment framework: Value of Technology (VOT), Value of Market (VOM) and Value Computation. By means of VOT the potential value of a technology (intrinsic and application-oriented) is depicted. The intrinsic factor involves technology describing aspects (i.e. ownership structure of a technology, degree of maturity and position in life cycle). The application-oriented factor considers the type of technology (i.e. material, product and production technology), the contribution of a technology for revenues to achieve and finally the application area. VOM shows the practical value of a technology, which is expressed in form of market or business processes. This module is distinguished between the technology value’s type and height. In the module Value Computation the contents of the two other modules VOT and VOM are combined and the risk is depicted with the help of adjustment factors. The approach from PARK and Park illustrates the context between technology potential and market chances, which is important for measurement, and delivers valuable preliminary consideration for this paper.

BABINI worked on a model for analyzing the utilization of technology potential by a company and a model for measuring the technology strategy [16]. This approach is connected with the integrated approach of technology management according to TSCHIRKY and is also known by Technology Value Analysis [17]. In comparison to investment appraisals the Technology Value Analysis allows a statement about the impact of a technology plan on the company’s value [17]. BABINI sees common ground on the measurement of technology strategies and the company valuation taking expenses and revenue under consideration [16]. To measure a technology strategy the life cycle of a technology is taken under consideration and follows on a basis of the Shareholder-Value-Approach according to RAPPAPORT. Consequently the Net Present Value (NPV) of a strategy or a project can be calculated [18]. Nevertheless BABIBI does not illuminate in his work, how the technologies to be measured can be distinguished respectively the cash flow determined. Merely the basic thoughts for measuring strategies can be considered as suggestions for this paper to analyze the objectives of technology leaps.

SCHÖNING develops a method for the potential-based, monetary measurement of new technologies based on the Discounted-Cash-Flow-Method. The model is separated into five component models, in which the technology potential is described by its technological performance parameters at first. In a next step, the potential benefit of a technology in its application context needs to be determined. Further the model of market potential analyzes the technology's commercial effects of a technology. In another model the value of a technology can be measured based on Net Present Value approach [19]. SCHÖNING delivers a valuable method for assessing the potential of a new technology and its commercial benefit. Yet the author assumes the periodic cash flows of a technology to be static, a priori fixed parameters and does not consider uncertainties through internal implementation risks or external market risks. Altogether the results of his work provide valuable input data for this ongoing work considering the parameter based description of technology potentials.

The works presented represent a basic source of information for this paper and ongoing research. However, these works only deal with single aspects such as objectives of technologies, influence of technologies and assessment of technologies, and just briefly cover the specific issue of technology leaps. Thus, a holistic framework for the assessment specifically of technology leaps needs to be developed.

In the following section the relevant constituent characteristics of technology leaps is presented as well as an approach for differentiating different types of technology leap. Further, a rough framework for assessing the potential of technology leaps is being presented.

## METHODOLOGY/ CHARACTERISTICS OF TECHNOLOGY LEAPS

After analyzing the existing literature with respect to technology leaps and identification of deficits the authors of this paper have developed a new approach for defining technology leaps. The foci of this approach are the technological aspects of a technology leap, differentiating clearly between technological and market related innovations. The dimensions applied for characterizing technology leaps are the following: basic technology (same and different) and its main technological performance criteria (same and different) (see Figure 4). "Basic technology" is understood as whether a technology leap comprises of the change from one technology to another technology with a different basic technology or whether the technology leap refers to a major performance improvement with respect to the reference basic technology. Main technological performance criteria are crucial for describing technologies and their potential. If companies fail to determine the right and relevant main technological performance criteria, the measurement is being blurred and often not representing the reality. The result is a four field matrix containing three relevant fields: technological leap, regular technology leap and disruptive technology leap. The fourth field describes the case when the assessment of a specific technology gets adjusted due to for example wrong chosen assessment parameters in the past. So, this fourth case will be neglected in this paper.

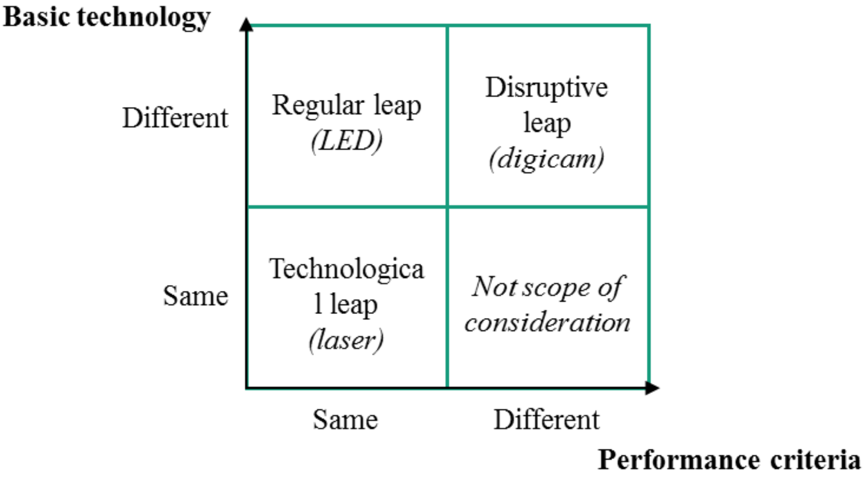


**Figure 5 – New approach for defining technology leaps**

Technological (not technology) leaps do not change the key parameters of its basic technology, so they also keep the same assessment or measurement criteria as before. Following the concept of S-curves according to TWISS a technological leap's technology stays on the same S-curve as before, but increases its technological progress with a major leap forward (see Figure 5). An example is intended to illustrate a technological leap: In the past there did not exist any technological possibilities to use lasers. Through advancement in laser technology this was made possible, so that laser supported systems were introduced. A recent application of this technology is laser supported machining. Through the local heating immediately before the machining by the laser, the characteristics for machining get vastly improved. This example shows that the main functionality of machining stayed the same, but got vastly improved by application of laser support.

Within regular technology leaps the basic technology does not stay the same, but is replaced by a new, more effective technology, at which the measurement criteria do not change. Concerning the concept of S-curves, there is one S-curve for the old and one for the new technology. After a certain time the S-curve reaches a higher level of potential than the old one, so the new technology is "worth it" to be used. For example, conventional light sources get replaced more and more by LED lamps, since they deliver about the same results regarding light quality, but work at much more efficiency. The basic technology changed as well from "heating a wire filament" to "applying voltage to a semiconductor".

In comparison to that there is the disruptive technology leap, which, as well, is displacing an established technology with a new one. The difference to the regular technology leap is that the displacing technology is usually developed without knowing its final application area from the beginning, which leads to different measuring criteria. (According to CHRISTENSEN "disruptive technologies are technologies that introduce a different performance package from mainstream technologies and are inferior to mainstream technologies along the dimensions of performance that are most important to mainstream customers." [5]) An example for that is the market displacement of analog with digital cameras; within few years the whole market had to change its thinking from the traditional, established way to a complete new one.

In summary we have the three types of technology leaps "technological leap", "regular technology leap" and "disruptive technology leap". Assessing the technological progress at the development of incremental progresses, there is a fluent transition between incremental progresses and technological leaps. This leads to the conclusion that a technological leap can be seen as one "big incremental progress", for which companies do not have to look for especially. Instead it is rather a duty to determine upcoming technological leaps to ensure a successful management anyways. In conclusion it is necessary to go deeper into analysis of the other, more complex technology leaps "regular leap" and "disruptive leap".

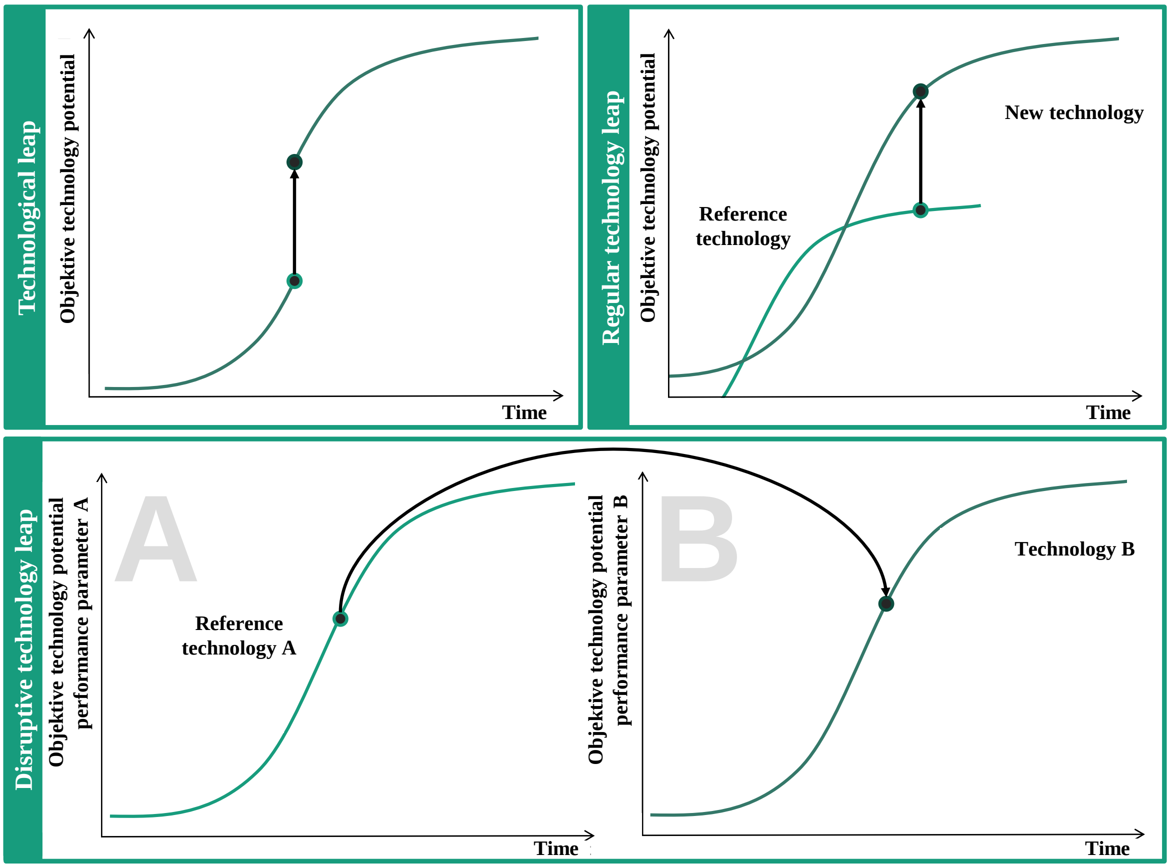


**Figure 6 – Depiction of the three types of technology leaps**

The technology leaps "regular technology leap" and "disruptive technology leap" are the most important but also the hardest to manage technology leaps that companies have to look on. There is no method which could help to handle or even analyze past technology leaps yet. Therefore the first step needs to be to determine the distinguishing characteristics of technology leaps.

First of all technology leaps are able to neutralize existing restrictions, which were to date an obstacle for technology´s commercialization. That might be any technological problem, which could not be solved before, maybe because there was no technological solution for a specific problem, or simply was too expensive, so an economically feasible application was not possible. At the current topic of additive production processes, such restriction might be the manufacturing process´ limited build-up rate. If the build-up rate was substantially increased by any technological solution in the future, this technological restriction could be neutralized for example.

But what is about the comparability of past and new technologies, when the measurement criteria change? You cannot just tell if a specific parameter is higher or lower than before.

Exactly this is the typical characteristic of disruptive leaps as shown above. This raises the question of how performance parameters can be determined and analyzed after all. Another distinguishing characteristic goes in the same direction. It deals with the fact that a technology leap has to exceed the performance of the past technology in a certain degree; otherwise it cannot be spoken of a "leap". How these performance parameters can be defined, and determined, in which dimension the advancement needs to be, presents another great challenge for companies.

To asses technology leaps a potential based measurement can be consulted. Here the objective and subjective potential of a technology leap can be distinguished. The objective technology potential describes the technology potential, which does not show any reference to a specific company yet, respectively has no company-specific influence. To determine the subjective respectively company-specific technology potential it is necessary, to identify those factors at first, which influence the technology potential of company side. Therefore the subjective technology potential describes how a technology applicator can use the objective, technological potential of a substitution technology and which company-related factors as resources, abilities etc. needs to be considered, which restrict the exploit of the theoretically possible potential. Thus the subjective technology potential presents a subset of the objective potential.

## CONCLUSION AND RESULTS

The literature review and deficits analysis have illustrated the current status of research in the field of technology leaps and potential assessment of technology as well as technology leaps. In addition, the paper has proposed a new approach for characterizing technology leaps and its constituent characteristics. Further, a rough framework for the potential assessment of technology leaps has been presented. Both science and industry demand for a reliable, holistic and applicable method for quantitatively assessing the potential of new, innovative technologies.

Technology leaps can be characterized as technological developments with a major (potential for) increase in technology performance. Also technology leaps are associated with higher technological and market risks as well as uncertainties compared to incremental technology developments. Also technology leaps require a longer time horizon for technology development and launch, since technological progress demands relatively high research and development effort, compared to disruptive innovations. Disruptive innovations employ established technologies and address new market segments, whereby the launch time is relatively short. Technology leaps can be classified using the dimensions "basic technology" (changed, unchanged) and "measurement criteria" (same, different). The results are four types of technology leaps. Therefrom three are relevant for this study, since the last one only occurs in exceptional cases. These three relevant types of technology leaps are "technological leap" (same basic technology, same measurement criteria), "regular leap" (change to different basic technology, using the same measurement criteria) and "disruptive leap" (change to different basic technology, using other measurement criteria). Based on this typology, users are able to gain a better understanding of technology leaps and how to characterize them. The distinguishing constituent characteristics of technology leaps are the elimination of existing restrictions and on a substantial technology progress compared to the previous technology.

In order to assess the potential of the different types of technology leaps, the theoretically (company-independent) possible potential and the subjective (company-specific) potential for companies need to be determined. In this step the definition of the right and relevant performance parameters, i.e. measurement criteria for assessing technologies is crucial for its validity. In terms of "technological leaps" or "regular leaps" the same measurement criteria can be applied. But in order to assess the potential of "disruptive leaps" other measurement criteria are required, because the established and the new, innovative technology differ in their essence and function principle. Determining the right and relevant measurement criteria for assessing the potential of technology leaps is a difficult task which needs to be solved in future. Further, a quantitative formula needs to be developed in order to be able to assess the potential of technology leaps. With the help of a suitable measuring method as the "expected cash-flow-approach" in future expected deposits and withdrawals, which accompany a technology leap, can be modelled by taking uncertainties into account.

This approach is intended to help technology oriented companies to gain a better understanding of technology leaps. By assessing technology leaps not only the theoretically possible potential of a technology is to be addressed but also the specific potential for the company.

**REFERENCES**

[1] Tushman, ML, Anderson, P. (1986) Technological Discontinuities and Organizational Environments. *Administrative Science Quarterly*.

[2] Anderson P., Tushman, ML. (1990) Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change. *Administrative Science Quarterly*.

[3] Kalbach, J. (2015) Clarifying Innovation: Four Zones of Innovation. https://experiencinginformation.wordpress.com/2012/06/03/clarifying-innovation-four-zones-of-innovation/.

[4] Bundesministerium des Innern/Bundesverwaltungsamt (2015) Handbuch für Organisationsuntersuchungen und Personalbedarfsermittlung. Berlin.

[5] Christensen, C.M. (1997) The Innovator´s Dilemma. When new technologies cause great form to fail, Boston: Harvard Business School Press.

[6] Twiss, B.-C. (1988) Forecasting for Technologists and Engineers, Short Run Press Ltd., Exeter.

[7] Bower, JL., Christensen, C.M. (1995) Diruptive Technologies: Catching the Wave. *Harvard Business Review*.

[8] Baba, Y. (1989) The Dynamics of Continuous Innovation in Scale-Intensive Industries. *Strategic Management Journal.*

[9] Glasmeier, A. (1991) Technological Discontinuities and Flexible Production Networks: The Case of Switzerland and the World Watch Industry. *Research Policy.*

[10] Henderson, RM., Clark, KB. (1990) Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firmes. *Administrative Science Quarterly.*

[11] Ehrnberg, E., Jacobsson, S. (1997) Indicators of Discontinuities Technological Change: An Exploratory Study of two Discontinuous in the Machine Toll Industry. *R&D Management.*

[12] Abernathy, W., Clark, K. (1985) Innovation: Mapping the Winds of Creative Destruction. *Research Policy.*
[13] Christensen, C.M., Bower, JL. (1996) Customer power, Strategic Investment, and the Failure of Leading Firms. *Strategic Management Journal.*
[14] Schuh, G., Klappert, S. (2011) Handbuch Produktion und Management: Technologiemanagement, 2. Auflage, Berlin.
[15] Park, Y, Park, G (2004) A new method for technology valuation in monetary value: procedure and application. *Technovation Nr.24.*
[16] Babini, M. (1992), Merz, M.: Wie können Technologie-Strategien bewertet werden?. *IO Management. Jg., 61. Nr.3.*
[17] Tschirky, H. (1998) Konzepte und Aufgaben des Integrierten Technologie-Managements. *Technologie-Management: Idee und Praxis.*
[18] Tschirky, H. (2003) The Concept of Integrated Technology and Innovation Management. *Technology and Innovation Management on the move.*
[19] Schöning, S. (2006) Potenzialbasierte Bewertung neuer Technologien. *Berichte aus der Produktionstechnik.*