# Technology Evolution Opportunity Mining (TEOM) for patent analysis and strategic invention

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## Abstract

Whoever wants to foresee the future, it is worth reading the current state of art described in the patent. TRIZ innovation research community has delivered a few guides to predict future direction corresponding to the general evolution patterns of technical systems. To strengthen future evolution prediction, the authors have proposed a novel approach, combination of evolution map and user context study to visualize a promising direction of innovation and new opportunities of intellectual properties. The authors developed a unique collaborative patent analysis system, EMS (evolution map system) to analyze big number of patents and figure out evolution map aligning with current patent status. To identify the opportunity of the intellectual property, an approach so called TEOM (technology evolution opportunity matrix) has been applied following big picture layouting. TEOM provides clearly the occupied evolution coordinates which are technically meaningful. The more valuable outcome of TEOM is the unoccupied coordinates in the current patents set, which could ignite novel and feasible IP candidates for the future. Combining unoccupied coordinate of the TEOM and user context study, the field inventors could have recognize the current evolution status as well as new opportunity of IP. The authors expect that evolution map approach could contribute to analyze patents with long term evolution vision and to deliver new intellectual properties.

## 1. Introduction

### 1.1. Motivation

Since 2000 information and telecommunication technology has been developed hyper-rapidly, predicting promising direction of the future divides literally life and death of a company. It is inevitable for any company to change its own DNA for survival, which means a future prediction tool should 'read' as well as 'lead' 'inter-species' evolution across the traditional technology boundary. One more requirement for future prediction tool is seamless link to technical solution as well as intellectual property aligned with customer's desire and needs. The authors hypothesized that TRIZ's evolution theory could provide a promising work-frame to read evolution path, estimate future trajectory and create new intellectual properties.

### 1.2. Scope and Objective

Many people want to figure out the future. "Evolution trends of technology" [1] could accelerate this process. Samsung Electronics has recognized the value of evolution lines of TRIZ and has tried standardizing 30 evolution patterns and implemented them into I-Spark(Samsung Electronics' own TRIZ software, Figure 1) and applied them for prediction as well as problem solving since 2008[3], summarizing the previous work done by Altshuller[1] and western TRIZ researchers[2]. Applying the evolution patterns to patents, it is possible to visualize a figure that looks like a phylogeny tree of biological evolution, so called evolution tree [4].
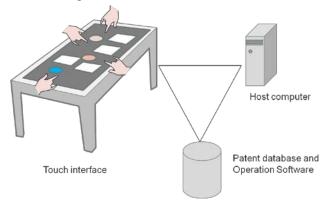


Figure1. Samsung's 30 evolution patterns in I-Spark

As the inventors play the most important part of the innovation, they need to learn patents set as soon as possible with balanced point of view for big picture and detailed fringe. The purpose of this study lies on providing a guideline for the inventors to acquire patent information as soon as possible. The other purpose of this study to suggest a tool that evolution theory could contribute to the real field work with minimal labour and maximal outcomes.

## 2. Results and Discussion

### 2.1. Approach

The focus of this research is divided into two fields, firstly, how to interpret patent information effectively and efficiently, and secondly, how to ensure creating future

patent concepts which reflects 'real needs' of future customers. In order to deliver evolution map from massive number of patents, the authors developed a working infra so called EMS (evolution map system, Figure 2), a human-computer interface to analyze patents and draw an evolution map in 2014.



(a) EMS physical layout



(b) Patent classification      (c) map visualization
Figure2. Multi-touch patent analysis and layout interface EMS (Evolution Map System)

Physically EMS is a 60 inch table top display with IR multi-touch frame on it (Figure 2 (a)). The multi-touch interface deals up to 30 touches on which 4 people could move the virtual patents cards with essential bibliographical information. The input of EMS is a large number of patents in excel format and the outcome is a patent database set with a classification structure and an evolution map in which an evolution hypothesis and steps of evolution are organized matching with relevant patent evidence.

EMS has 2 working sub-modules: the first for classifying patent information and the second for lay outing an evolution map based on classified information(Figure (b), (c)). The first module, patent clustering module, can take up to 10,000 pieces of patent information and visualize data on the screen (titles, applicants, filing dates, representative drawings, abstract, independent claims) as A4 size virtual card format. After reading the information written on the "patent card", the analysts put the similar patents together using multi touch interface into a same "binder". At this time, proper name of the binder was defined by the analyst team. To ensure the reliability of the patent classification system, analysts make in depth communication during clustering the cards.

Up to now EMS can provide two levels of bottom-up clustering.

The next step of the patent classification is proposing new evolution hypothesis to understand past, present and probable future 'without' EMS. To induce hypothesis of evolution, Samsung's 30 evolution patterns [3] as well as Altshuller's classical evolution trends [1] are referred. If it is impossible to discover the appropriate trend which can explain real patents trend; the analysts defined our own evolution hypothesis based on the ideality axiom of the classical evolution trend [1].

Visualization module helps the analysts connect the pre-classified patents with the evolution hypothesis. Evolution hypothesis maps can be shaped as tree type or matrix type map so called TEOM [5]. Current EMS v.1.0 supports tree type layout (1.x dimension) only. In 2017, matrix type evolution map (over 2 dimensions) i.e. TEOM also has been systemized as independent software which can be used aligned with EMS.
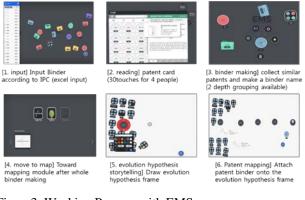


Figure3. Working Process with EMS

### 2.2. Case Study. Home Robot's Future

In early 2015, the authors started analyzing more than 2,600 US patents under the theme of home robot to predict evolution as well as novel patent concept. The main goal was to discover 'new and useful use case' and corresponding patents to obtain intellectual property prior to any other competitors. As traditional TRIZ technique is lack of understanding user context and picking up the user's unmet needs, the authors invited other methodologies for customer context study, for example, personal, role playing, customer journey map with patent evolution map (Figure 4, 5).
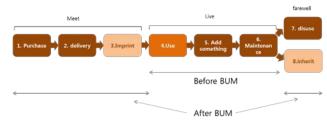


Figure 4.Buyer's Utility Map for Home Robot

Figure 5.Several User Context Studies

The authors could induce 14 different evolution driver hypotheses, where 3 evolution drivers were selected to figure out evolution maps as following: 1) Home robot learns me more and more, 2) Home robot has more engagement with me, 3) The value provided by the robot increases. Hypothesis "Home Robot learns me" was likely to evolve following steps denoted in Figure 6. In the 1st step, robot is insensitive to learn me. Step 2 corresponds to the present stage "robot starts recognizing me".
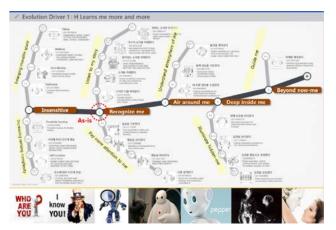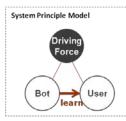


Figure 6. Home Robot Evolution Map - Robot learns me more and more

A robot might understand air around me in the next evolution step 3. Efforts to create new concepts were focused on the step 3 because it was most likely to be the next stage of the 'present'. The team investigated the profile of related persona , organized 1,101 conscious, unconscious daily home life event in Figure 5, which were used for investigate opportunity of new function at the 'air around me' steps. To ignite 'new S-curve' on the next evolution stage, it is mandatory to imagine 'new function' which might attract the customers' purchasing desire the next stage.

Figure 7 shows the journey to create the new patent concept how to identify 'me' with the several energy sources where it comes from. Based on the big picture of evolution map in Figure 6, system function principle

model could be drafted presented in Figure 7(a) composed of 'bot' as a tool, 'me' as an object, 'F' as an interaction field between the object and the 'bot'. Each element of the principles model follows its own 'small-scale' evolution line, for example, 'F' can follow 'substituting field types' such as MAThChEMEm scale(Figure 7(b)). The authors combine the field evolution hypothesis with the high level evolution driver of 'bot learns me' induced by big evolution map denoted in Figure 6 to make an evolutionable-space so called TEOM (Figure 7(c)) [5].
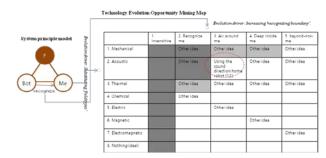
After constructing TEOM matrix frame, the authors could evaluated each patents based on the new developed field evolution lines to 'recognize me'. Visualizing the evaluation results in Figure 7(c) shows not only the space where the competitors have already occupied (gray cell), but also the space where little/no competitors have occupied (white cell). The authors focused on suggesting new ideas for 'white space', where was 'free' from other intellectual properties. Real ideas came from the blank coordinates, (X, Y) = (3. air around me, 2. acoustic), of Figure 7(c), which could be a seed point for future patent following.



(a) System principle model of 'recognizing me'



(b) Referred evolution pattern for the driving force



(c) Evolution space designated by TEOM
Figure 7. TEOM schema

Once a new concept derived, the idea was converted to a search query for a prior art search to verify the real new-ness of the concept in the world. After confirming new-ness of the derived concept by a couple of preliminary prior art searches, a discloser of invention were drafted

based on the literally 'new' concept. A combined approach – evolution map, customer study and TEOM– the team were able to create 72 technically meaningful concepts which meet the next stage customer needs. 3 ideas were chosen to be applied as US/Korea/World patents patents [8-10].

### 2.3. Discussion

*Bottom-up vs. Top-down*

There are 2 different ways to classify massive numbers of patents. Traditional one is top-down taxonomy hierarchy [11]; making pre-defined technology tree structure and matching the individual patents to the fixed structure. The alternative one is a bottom-up classification; collecting similar information into one and making a common name for the collected information step by step upward.

More than 50,000 patents analysis experience gave a lesson to the authors about which one is better than the other. Even if it is clear and fast to classify the big number of information, top-down classification has proven its limitation to re-organize and re-structuralize current function-tree structure to absolutely new ways, which might be the essence of 'inter-species' technology evolution. On the other hand, bottom-up classification was very tedious and slow but it could deliver very flexible superimposing cluster structure, which enabled the analysts to organize more flexible and open technology hierarchy structure which might include inter-species transformation. As the main purpose of the evolution map is not only analysing current status of technology but also fore-seeing novel direction of future 'inter-species' evolution, bottom-up clustering is more recommendable than top-down analysis. At this point, the author recognized a need for a systematic SW and operation process supporting bottom-up analysis for evolution map, of which detail is described as following.

*Human interaction vs. Information analysis itself*

EMS (Evolution map system), a novel patent information clustering system was developed to facilitate bottom-up classification process with minimizing human labour. The philosophy of EMS is not just analysing information itself by computing only but also igniting human beings (the analyst team) to make more verbal communication which might enlighten novel evolution direction surpassing conventional paradigm. Patent information could be intuitively classified through finger touch and active verbal communication between the participants, which might induce new classification categories. The 30 touches interface with 60 inch visual display of EMS allows 4 people to communicate very freely with their tongues as well as their fingers. EMS won

a Samsung work smart award at the end of 2014 for its ability to effectively communicate among participants and classify a large amount of patent information. The information classification user interface structure was also filed up as a Korean patent [12]. To facilitate patent analysis of detailed point of view, personal patent evolution analysis SW, TEOM light and its descendent TEA (technology evolution assimilator) are also under developing by the authors supported by natural language processing technology, which might be published later.

*Balancing Empathy and Technology*

In addition to the direction of the evolution of the big picture, it is crucial to understand where, when, why, for whom the product is to be used, i.e. the actual needs or hidden desire of the (future) users. As TRIZ evolution theory and classical TRIZ holds very limited tools for emphasizing user, the authors implemented special tools such as customer journey map in service design[7] and BUM(buyers utility map) in blue ocean strategy[6] out of TRIZ world. Customer journey map promoted the team members to recognize 'un-known' lifestyle and 'unsaid' pain points of our customers following everyday life shadowing or role-playing. BUM helps the team members to think the other part of product before and after 'usual using'. The approach of this study, which harmonized emotional activities after rational activity, helped researchers obtain clearer scenario of future.

*Impact on the IP Strategy*

For a long time, TRIZ has been well-known methodology of problem solving to Samsung people. The core value of this study is to prove the strategic value of TRIZ evolution theory for strategic IP creation. The team members made their own evolution framework based on TEOM [5] and applied it to prepare further evolution portfolio map of patent developing engineering division, which means TRIZ evolution theory contributed strategic field of patent development, as well as creation of individual patents to solve specific engineering problem.

## 3. Conclusions

To discover promising patents in the near future, a novel approach based on evolution map has been proposed in this study. In the beginning, large numbers of patent information were classified and corresponding evolution hypothesis map was visualized based on TRIZ evolution theory. Multi touch information-user interface EMS was developed to assist classifying lots of patents and visualizing evolution trend. After visualizing evolution map, the authors could deliver challenging evolution direction as well as tangible disclosure of invention with

minimal trial and error by configuring TEOM structure with aligning system schema and detailed evolution line for the selected patent data. The weak point of TRIZ evolution theory to understand user's context, other method like customer journey map and buyer's utility map were coupled with the patent evolution study. A case study of home robot could prove usefulness of the evolution theory to create strategic IP of Samsung Electronics. The authors expect that evolution map based intellectual property design method would guide whoever wants big strategic jump and tangible intellectual properties.

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