

Second innovation process based on extension engineering method

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Abstract: Through the analysis of the development process of second innovation, the common process of “post second innovation” was brought forward by means of the extension engineering method. Meanwhile, as an example, the mechanical product was analyzed and obtained a satisfactory product of conclusion innovation. The common process of “post second innovation” brought forward in this text has universality, which can be used in other product innovation and other innovation form, through integrating practical condition. So in the paper, we provide researchers and technicians with a new idea.

Keywords: Extension, Second innovation, Technical innovation

1. Preface

In the past few years, the research of extension has obtained the substantial development. However there are still many important problems unsolved. For example, the theory hasn't applied to the innovation process. So, this text will apply the extension engineering method to second innovation process.

In essence, extension method has been applied to the development of the new products long before (Cai, 2000), but to such developing countries like china,

second innovation process should be urgently studied. Based on the introduction of technology, we can find another way to technology innovation and push technology development. Second innovation refers to the market condition based on the introduction of technology and limited by technology form and self-integration in hand to find a new technology trail.

Indubitably, it is the key and the only way for junior nations, especially developing countries to take the second innovation strategy. In this way, they can form “afterwards advantage” and catch up with developed countries. A good “second innovation” case in point is the success of Japan and Korea. Differ to traditional innovation ideas which digest to absorption. Second innovation goes through all digestion and absorption process of the introduction of technology. It is limited by the inborn “technology form”, but it can develop with decided “technology route”. It is the main way for junior nations to form their own way of development through afterwards advantage and narrow the gap with developed countries.

Because of the differences of technology cadre, technology ability, economy development level, education, culture and so on. The self-development ability of developing countries are accumulated in such a way is as digestion and absorption based on the introduction of technology from developed countries. Research on the innovation of developing countries, we must connect it with the introduction of technology just as technology innovation to developed country. The introduction of technology is element and method, while the technology innovation is the aim and result. As a developing country, the two parts can't be separated. So, we should take the dynamic development process of developing country as the basic point of doing researcher on enterprise technology system.

The second innovation is a dynamic process, which stayed on the transition from the second innovation to the first innovation and the formation of country's or enterprise's innovation production. In the process of technology innovation, because of the differences of the technology introduction, there are some differences in the second innovation development process. For example, the introduction of technology in our country emphasizes particularly on completely copying the whole product line formerly. On the latter stage, we emphasize particularly on the introduction advanced and new technology, in order to domestic production process and technology. With this theory we divided the second innovation into four categories (Sun & Wang, 2003):

A. Imitation innovation. This is a second innovation of “study in work”. In the process, import countries introduce the mature technology from export country. Based on digesting and absorbing, they renew the equipment and technology, and then improve on the flow and product technology.

B. Creative imitation. Based on technology structure in hand, the import country introduces the mature technology from export country. Then, they blend the two kinds of related technology to realize the domestic production of technology.

C. Introduction innovation. Based on knowledge, technology and experiment in hand, the import countries integrate the foreign new technology to achieve their researching and developing ability gradually.

D. “Post second innovation”. Based on having the introduction of laboratory technology and foreign technology, the import countries research and develop to achieve breakthrough of technology form and leap of the technology route initiatively.

Here, as an example, “post second innovation” is analyzed with extension method.

2. The common process of “post second innovation”

The main characteristic of “post second innovation” is the import countries introduce the laboratory technology from export countries, digest and absorb research and develop by integrating their domestic technology. So this process is difficult and risky. Here, based on its general exploration character, we try to put forward a common form with extension way for the technicians to refer to. It is as follows:

step1. Denotation the laboratory new technology of technology export countries with matter-element (Cui, 2010). Defined as $R_1^1, R_1^2, \dots, R_1^n$.

step2. Employ the innovation technology impelling theory to find the application field of this technology, and according the requirement of the new product in this field, seek the domestic available mature theory, with matter-element defined as $R_2^1, R_2^2, \dots, R_2^n$.

step3. With the technology above, finding the soft matter-element(way of connection) denotation with $R_3^1, R_3^2, \dots, R_3^n$.

step4. With matter-element expensive nature, form new matter-element $R_4 = (R_1^i \oplus R_2^i) \otimes R_3^i$.

step5. With the three kinds of new products exploitation divergent R_4 , then form a series of new products $R_5^1, R_5^2, \dots, R_5^n$.

step6. Apply the theory of market demanding technology innovation to primarily evaluate the products.

step7. More new technologies are introduced, so the new product R_6 which is required in market is formed.

step8. Bring forward improvement measurement based on the domestic application. So bring forward the method of solving problem. Meanwhile, based on the solution way, the goal matter-element was written with R_7 , term matter-element with R_8 . From goal matter-element to extension, we get a series of new products $R_9^1, R_9^2, \dots, R_9^n$.

step9. Evaluate those products, and then choose the best product, written as R_9 .

3. Case applications

Take patrol machine for example, sediment vibration filter is applied in oilfield extensively, on which Japan has the advanced technology. Here, as to the technology introduction and innovation, we can illustrate it with the above extension.

At the initial development stage, Japan researched three laboratory technologies with object inertia theory and machine vibration theory. The first is partiality electric motor product technology which can produce high frequency vibration at driving of 380V industry alternating current. Meanwhile, partiality electric motor has the virtue of small volume and long life. The second is metal connect technology which has the merit of resisting crash and resisting abrasion. Meanwhile the technology is simple. The third is high mesh filter production technology which makes filter have the event and little mesh.

step1. These three technologies can be written as follows by matter-element:

$$R_1^1 = \begin{pmatrix} \text{partiality electric motorA} & \text{function} & \text{produce vibration} \\ & \text{frequency} & \text{high} \\ & \text{volume} & \text{little} \\ & \text{life} & \text{long} \\ & \text{vavage} & \text{380V} \end{pmatrix} \quad R_1^2 = \begin{pmatrix} \text{cohere technolog y P} & \text{function} & \text{metal connect} \\ & \text{resisting impact ability} & \text{strong} \\ & \text{technique complicity} & \text{low} \end{pmatrix}$$

$$R_1^3 = \begin{pmatrix} \text{mesh S} & \text{function} & \text{material} & \text{separate} \\ & \text{bore number} & & \text{high} \\ & \text{filter grain degree} & & 80 \end{pmatrix}$$

step2. Through analysis, the technology R_1^1 can be applied in architecture industrial, meanwhile our country have the high-strength wield technology,

$$R_2^1 = \begin{pmatrix} \text{wield technolog y}W_4 & \text{function} & \text{metal wield} \\ & \text{strength} & \text{high} \end{pmatrix}$$

written as

step3. Based on the technology above, we look for the soft matter-element (Cai, 1998). Here, R_2^1 can be looked as soft matter-element, meanwhile the metal crust can be looked as another hard matter-element (Cai, 1998), written as

$$R_2^2 = \begin{pmatrix} \text{crust M} & \text{material} & \text{metal} \\ & \text{function} & \text{truss} \end{pmatrix}.$$

step4. Those two technologies can be integrated with expansive nature to produce the tamping machine which applied in architecture industrial. Written as

$$(R_1^1 \oplus R_2^2) \otimes R_2^1 = R_4 = \begin{pmatrix} \text{tamping machine H} & \text{work theory} & \text{high frequency vibration} \\ & \text{function} & \text{tamp ground} \\ & \text{technique} & \text{wield} \\ & \text{volume} & \text{small} \\ & \text{applied field} & \text{architecture} \\ & \vdots & \vdots \end{pmatrix} \begin{pmatrix} N_0 & v_1 & c_1 \\ & v_2 & c_2 \\ & v_3 & c_3 \\ & v_4 & c_4 \\ & v_5 & c_5 \\ & \vdots & \vdots \end{pmatrix} \begin{matrix} \Delta \\ \Delta \\ \Delta \\ \Delta \\ \Delta \\ \Delta \end{matrix}$$

where R_4 stands for the new product through connecting partiality electric motor R_1^1 and crust R_2^2 with wield technology R_2^1 .

step5. With the second innovation method, we create the new product from production R_4 .

Here, when we conceive new production, we should think of those functions which R_2^1 and R_1^1 have. So, it is satisfied with

$$R_4^1 = \begin{pmatrix} \text{new product N} & \text{work theory} & \text{high frequency vibration} \\ & \text{technique} & \text{wield} \end{pmatrix} \begin{pmatrix} N & c_1 & v_1 \\ & c_2 & v_2 \end{pmatrix} \begin{matrix} \Delta \\ \Delta \end{matrix} \begin{pmatrix} N & C & V \end{pmatrix}.$$

With the method of divergent tree, looking for the matter-element N_i which satisfied with duality characteristic-element

$$R_4^1 = (N \quad C \quad V) \xrightarrow{\text{extension}} \left\{ \begin{array}{l} (\text{tamp machine} \quad C \quad V) \\ (\text{vibration filter} \quad C \quad V) \\ (\text{magic treatment machine} \quad C \quad V) \end{array} \right\}.$$

Get divergent set of matter N , written as :

$$N_D(N) = \left\{ \begin{array}{l} \text{tamping machine, vibration filter,} \\ \text{magic treatment machine} \end{array} \right\}, \text{divergent other characteristic-element of } N$$

which related to N_0 , for example,

$$\begin{aligned} V_D(v_2) &= \{\text{tamp, filter, treatment}\} V_D(v_2) = \{\text{wield, inset, paste}\} \\ V_D(v_4) &= \{\text{architecture, mine, factory, power, oilfield}\} V_D(v_5) = \{\text{small, middle, big}\} \end{aligned}$$

Make transformation of matter-element, so we can get a series of new product, written as $R_5^1, R_5^2, \dots, R_5^n$, therein, we get:

$$R_5^1 = \left(\begin{array}{ccc} \text{vibration equipment } B_1 & \text{work theory} & \text{high frequency vibration} \\ & \text{function} & \text{filter} \\ & \text{technique} & \text{wield} \\ & \text{volume} & \text{big} \\ & \text{applied field} & \text{oilfield} \end{array} \right) R_5^2 = \left(\begin{array}{ccc} \text{magic treatment } C & \text{work theory} & \text{high frequency vibration} \\ & \text{function} & \text{treatment} \\ & \text{technique} & \text{inset} \\ & \text{volume} & \text{small} \\ & \text{applied field} & \text{hospital} \end{array} \right) \dots$$

Here we discuss vibration equipment only.

step6. Based on market condition, we can apply the appraisal method of degree (Cui, 2005) to appraise the good or the bad of those new products. Here, we don't dwell on it.

step7. Here, the matter-element R_5^1 only is a goal matter. If it was changed into a product, R_1^2 and R_1^3 should be introduced. With matter-element's expansive nature, look R_5^1 and R_1^3 as hard matter-element and R_1^2 as soft matter-element. We can get:

$$(R_5^1 \oplus R_1^3) \otimes R_1^2 = R_6 = \left(\begin{array}{ccc} \text{vibration filter } B_2 & \text{function} & \text{separate solid from liquid} \\ & \text{work theory} & \text{high frequency vibration} \\ & \text{technique} & \text{wield} \\ & \text{volume} & \text{big} \\ & \text{applied field} & \text{oilfield} \\ & \text{filter grain degree} & 80 \\ & \text{filter mesh layer} & \text{single} \\ & \vdots & \vdots \end{array} \right).$$

Where, R_6 stands for the new product through vibration equipment R_5^1 and filter mesh R_1^3 connected with R_1^2 .

step8. With this technology, we should do the second innovation in order to make this technology domestic. When machine R_6 is used, there are some bad phenomena, such as mud-running. Severity mud-running proves that the flow of mud is too high which result in the low efficiency of vibration filter. There are two measurements to improve this condition. One is to increase the vibration power; the other is to increase the filter mesh. With extension nature of matter-element, we discuss the two measurements. According to the expansive nature, we can innovation the new product. Here, the expansive nature of machine means the method of increase in value from the components re-combines. Here, which performance changing the construction or combine way to get the goal (here the characteristics of R_7^1 , R_7^2 come from the characteristics of R_6).

$$\text{Term matter-element } R_7^1 = \begin{pmatrix} \text{vibration filter} & \text{vibration force} & F \\ & \text{vibration frequency} & a_1 \\ & \text{filter efficiency} & v \\ & \text{vibration degree} & 45^\circ \end{pmatrix}$$

Goal matter-element $R_8^1 = \begin{pmatrix} \text{vibration filter} & \text{vibration force} & 1.2F \\ & \text{filter efficiency} & 1.2v \end{pmatrix}$. Obviously, it is a feasibility problem.

The process of extension from goal matter-element is:

$$R_8^1 = \begin{pmatrix} \text{vibration filter} & \text{vibration force} & 1.2F \\ & \text{filter efficiency} & 1.2v \end{pmatrix} \xrightarrow{\text{extension}} \left\{ \begin{array}{l} R_6 \oplus R_1^1 = R_9^1 = \begin{pmatrix} \text{vibration filter} & \text{vibration force} & 2F \\ & \text{vibration frequency} & 2a \\ & \text{filter efficiency} & 2v \\ & \text{vibration degree} & 45^\circ \end{pmatrix} \\ R_6 \xrightarrow{I_6} R_9^2 = \begin{pmatrix} \text{vibration filter} & \text{vibration force} & F \\ & \text{vibration frequency} & a \\ & \text{filter efficiency} & 1.3v \\ & \text{vibration degree} & 55^\circ \end{pmatrix} \end{array} \right.$$

Here, R_9^1 stands for the new vibration filter which has two partiality electric motors. It come from R_6 which is increased another partiality electric motor. R_9^2 stands for the new vibration filter which is changed its partiality electric motor's vibration degree from R_6 by I_6 .

Here, we analysis the affair-element I_6 :

Goal affair-element is: $I_6 = \begin{pmatrix} \text{adjust} & \text{receive object} & \text{vibration filter} \\ & \text{extend} & +10^\circ \end{pmatrix}$

$$I_6 \begin{cases} \xrightarrow{\text{extension}} \begin{cases} I_6^1 = (\text{adjust} & \text{place} & \text{electric moter bracket}) \\ I_6^2 = (\text{adjust} & \text{place} & \text{filter grain}) \end{cases} \\ \xrightarrow{\text{extension}} \begin{cases} I_6^3 = (\text{adjust} & \text{tool} & \text{hydraulic}) \\ I_6^4 = (\text{adjust} & \text{tool} & \text{electromot ion}) \\ I_6^5 = (\text{adjust} & \text{tool} & \text{engine}) \end{cases} \end{cases}$$

We get affair-matter-element; $R(I_6^1) = \begin{pmatrix} I_6^1 & \text{drive demand} & \text{big} \\ & \text{operation velocity} & \text{slow} \end{pmatrix}$ $R(I_6^2) = \begin{pmatrix} I_6^2 & \text{drive demand} & \text{small} \\ & \text{operation velocity} & \text{fast} \end{pmatrix}$.

From element evaluation, we choose $R(I_6^2)$ as the final affair-matter-element. In common:

$$R(I_6^3) = \begin{pmatrix} I_6^3 & \text{operation} & \text{better} \\ & \text{security} & \text{fine} \\ & \text{veracity} & \text{high} \\ & \text{increase cost} & \text{high} \end{pmatrix} \quad R(I_6^4) = \begin{pmatrix} I_6^4 & \text{operation} & \text{better} \\ & \text{security} & \text{common} \\ & \text{veracity} & \text{high} \\ & \text{increase cost} & \text{middle} \end{pmatrix} \quad R(I_6^5) = \begin{pmatrix} I_6^5 & \text{operation} & \text{worse} \\ & \text{security} & \text{bad} \\ & \text{veracity} & \text{low} \\ & \text{increase cost} & \text{lowest} \end{pmatrix}.$$

From element evaluation, we choose $R(I_6^3)$ as the final affair-matter-element.

From the way of the feasibility problems, we can get the affair-matter-element as follow:

$$I_6 = \begin{pmatrix} \text{adjust} & \text{receive object} & \text{vibration filter} \\ & \text{extend} & +10^\circ \\ & \text{palce} & \text{filter grain} \\ & \text{tool} & \text{hydraulic} \end{pmatrix}$$

About filter mesh : Term matter-element is

$$R_7^2 = \begin{pmatrix} \text{vibration filter} & \text{vibration efficiency} & \text{v} \\ & \text{filter grain degree} & 80 \end{pmatrix}.$$

Goal matter-element is $R_8^2 = \begin{pmatrix} \text{vibration filter} & \text{filter efficiency} & 1.2v \\ & \text{filter grain degree} & x \end{pmatrix}$. Obviously, it is an unknown problem.

The process of extension from goal matter-element is :

$$R_8^2 \xrightarrow{\text{extension}} \left\{ \begin{array}{l} R_8^2 \oplus (-R_1^3) \oplus R_8^3 = R_9^3 = \\ \left(\begin{array}{lll} \text{vibration filter} & \text{filter efficiency} & 1.2v \\ & \text{filter grain degree} & 60 \end{array} \right) \end{array} \right\}.$$

Here, R_9^3 stands for the new vibration filter through changing the vibration from 80 to 60.

step9. A comment can be made among those three new products. As for R_9^3 , it will change the filter degree by changing the original grain requires, although it can satisfy the requirement of work efficiency. As for R_9^1 , it can satisfy all requirement, but it is expensive for increasing a motor. So we choose R_9^2 as the best project. So we can get the new project:

$$R_9 = \begin{pmatrix} \text{vibration filter } B_3 & \vdots & \vdots \\ & \text{filter efficiency} & 1.3v \\ & \text{vibration frequency} & 1.3a \\ & \text{vibration degree} & 55^\circ \end{pmatrix}$$

4. Solution

The second innovation process, as a process that needs analysis of comprehension usages of major knowledge and creative thinking, it is a very complicated process. As a subject of “finding way”, extension provides a new idea to second innovation. When we use it to make the second innovation, we should not only organize the clue according to the fixed method, but also partiality revises the whole process based on reality. For example, in this paper, we discussed the matter systematic (soft and hard) of machine. But, when we discuss the innovation of consumable, maybe we will think of the matter corporality (real and imaginative). However, the method bring forward in this paper provide a common idea to the product’s second innovation. It is practicability.

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