Innovation dynamics: decision making in changeable spaces based on habitual domains

Yen-Chu Chen

Abstract

Human behaviors involve dynamic, evolving, interactive, adaptive processes. Important decision making, as a part of human behaviors, is usually dynamic and involves changeable parameters. These parameters can interact with each other and vary with time, the situation, and changes in the psychological states of the decision makers involved. According to the habitual domains theory, decision making can reach a steady state and exhibit habitual patterns as time passes. As a consequence, people may unwittingly assume that the decision parameters have fixed known dimensions and ranges. However, in real life, the parameters might or might not be noticed. Even when they are noticed, their dimensions and ranges cannot be predetermined. Decision making with this kind of feature, is called “decision making in changeable spaces”. Corporate innovation problems are of this type.

Innovation itself is a dynamic process, which includes transforming competence sets for innovation, producing products or services to release the pains and frustrations of target groups, and creating and distributing value. In the field of innovation studies, no framework has systematically described these processes in the past. This research is the first attempt to integrate these components into a single system.

Business innovation itself involves decision making problems in changeable space, including transforming competence set for innovation, producing products or services to release the pain and frustration of target groups, creating values, and distributing values. Based on habitual domains theory and its related competence set analysis, this article introduces the concepts of habitual domains and decision makings in changeable spaces as to describe the dynamics of human behavior and the changing nature of decision making problems. It explores the expansion of competence sets and creation of value, and proposes an integrated framework, Innovation Dynamics. Two corporate cases are discussed to verify the framework. By examining the operations of each link in innovation dynamics, corporations can understand if each and all links are properly developed, so that they can continually upgrade their products/services and create maximal value by releasing the pains and frustrations in potential domains of customers.

Keywords: Habitual Domain, Decision Making in Changeable Space, Competence Set Analysis, Innovation Dynamics.
創新動態學：以習慣領域為基礎探討可變空間之決策制定

陳彥曲

摘要

人類行為乃由動態且複雜的流程所組成。決策行為係人類行為的一部份，因此亦含有許多動態變化的參數。這些參數互相影響，且會隨著時間、情境，乃至於決策者的心理狀態變化而有所改變。根據習慣領域理論，決策行為雖因不同參數的變化而改變，卻會隨著時間的經過而達到穩定狀態，並且具有習慣性；這使得人們常不自覺地假設決策參數的維度或範圍是固定的。然而在現實生活中，決策參數的變化並非固定在某特定範圍，甚至可能不為人所注意。具備這種動態特性的決策，稱為可變空間下的決策。企業創新問題即屬於可變空間下的決策問題。

企業創新本身是一個動態過程，包含了能力集合的擴展轉化，提供產品及服務以解除特定族群的痛苦與煩惱，創造價值並進一步分配價值；其中每個環節都涉及可變空間之決策制定。過去的創新研究中，缺乏整體性的架構以描述此一動態流程。本研究將以習慣領域理論為基礎，提出「創新動態學」此一動態循環架構，探討企業如何深入潛在領域，有效獲取、轉化其能力集合，滿足顧客需求，並且創造價值。文中並以知名企業為例進行驗證，期望透過個案探討方式幫助企業了解如何落實創新與創造價值，以提升企業競爭力。

關鍵詞：習慣領域、能力集合分析、可變空間下的決策、創新動態學。
I. INTRODUCTION

Human behaviors involve dynamic, evolving, interactive and adaptive processes. Important decision makings, as part of human behaviors, usually are dynamic and involving changeable parameters, too. Each decision problem may be characterized by various dimensions of parameters. It involves a number of elements such as decision alternatives, decision criteria, decision outcomes, decision preference, and decision information inputs. It also involves with the following four environmental facets: decisions as a part of the behavior mechanism, stages of the decision process, players involved, and unknowns in decision making. These parameters can interact with each other and vary with time, the situation, and changes in the psychological states of the decision makers involved. Although dynamic in nature, decision making, as a part of human behaviors, may reach a steady state and exhibit habitual patterns as time goes by. As a consequence, in mathematical programming or ordinary decision-making problems, we may unwittingly assume that the decision parameters (or variables) have fixed known dimensions and ranges. However, in real life, the parameters might or might not be noticed. Even when they are noticed, their dimensions and ranges cannot be predetermined. Decision making with these features is called “decision making in changeable spaces” [14-16].

Corporation innovation itself, which involves setting corporate goals, evaluating states, understanding customers’ needs, producing and providing products and services, and creating value for targeted customers and themselves, is of the type of challenging decision-making problems in changeable spaces. If corporate decision makers are not aware of the existence and changing nature of the relevant parameters in decision making, they may fall into decision blinds and traps [14, 17] and make serious mistakes.

In the last two decades, the researches about innovation have covered a wide range of concepts, methodologies and application areas which lead to an abundant literature [2-8]. However, those related studies on innovation seldom explored the key factor of successful innovation from the perspective of “satisfying or releasing potential needs, pains, and
frustration”. Innovation itself is a dynamic process which includes transforming a competence set for innovation, producing products or services to release the pains and frustrations of target groups, and creating and distributing values. In the field of innovation studies, there previously was no framework that systematically described these processes. This prompts us to study business innovation from the viewpoints of habitual domain and decision making in changeable spaces.

The rest of this article is organized as follows. In section II, the idea of decision making in changeable spaces is discussed. The concepts of habitual domain and competence set are introduced in section III and IV respectively. Decision blinds and traps are also discussed. In section V, the framework of Innovation Dynamics is proposed, and its verification is provided in section VI. Conclusion and further researches are summarized in section VII.

II. DECISION MAKING IN CHANGEABLE SPACES

To facilitate the presentation, let us use the following example to illustrate how the challenge problems are solved by looking into the possible changes of the relevant parameters.

A. Example1: The 1984 Olympics in Los Angeles

The 1984 Summer Olympics, officially known as the Games of the XXIII Olympiad, were held in 1984 in Los Angeles, California, United States. Following the news of the massive financial losses of the 1976 Summer Olympics in Montreal, Canada, and that of 1980’s Game in Moscow, USSR, few cities wished to host the Olympics. Los Angeles was selected as the host city without voting because it was the only city to bid to host the 1984 Summer Olympics.

Due to the huge financial losses of the Montreal and that of the Moscow, the Los Angeles government refused to offer any financial support to the 1984 Games. It was then the first Olympic Games that were fully financed by the private sector in the history. The organizers of the Los Angeles Olympics, Chief Executive Officer Peter Ueberroth and Chief Operating Officer Harry Usher, decided to operate the Games like a commercial product. They raised fund from corporations
and a great diversity of activities (such as the torch relay) and products (for example, “Sam the Eagle”, the symbol and mascot of the Game), and cut operating cost by utilizing volunteers. In the end, the 1984 Olympic Games produced a profit of over $220 million.

In the above example, new players, all the potential customers to the Olympic Games besides the athletes, were brought into the decision problems. When the organizers of the Los Angeles Olympics decided to focus on introducing more potential players into the decision problems and making good use of their competence, the old solution and alternatives, such as asking financial support from the government, were dropped, and the decision problems began to move in more effective and stable direction.

Example 1 shows us that in reality, the players, criteria, alternatives, perception of rules of games, and outcomes (part of decision parameters) are not fixed. The parameters, including their dimensions, are dynamically changed depending on how deep, how far and how broad we look into the potentiality (or potential domains as to be introduced shortly).

The fact that the parameters can themselves be the control or decision variables is a main feature of decision making in changeable spaces (of parameters).

B. Dynamic Changes of Decision Parameters

Mathematically, decision making in changeable spaces can be described as follows:

Assume that changeable decision parameters involve the following decision elements (extension to include other parameters can be done similarly):

(i) the alternative set at time \( t \), denoted by \( X_t \);
(ii) the criteria at time \( t \), denoted by \( F_t \);
(iii) the outcome measured in terms of the criteria at time \( t \), denoted by \( F_t \);
(iv) the preference of decision maker at time \( t \), denoted by \( D_t \); and
(v) the information inputs at time \( t \), denoted by \( I_t \).

Each decision element is a set which can vary with time, situation, and the decision maker’s perception to the decision problems. The alternative set at time \( t+\Delta t \) can be denoted by

\[
X_{t+\Delta t} = G (X_t, F_t, D_t, I_t, HD_t)
\]

where \( HD_t \), consisting of actual domains \( (AD_t) \), reachable domains \( (RD_t) \), potential
domains \((PD_t)\) and activation probability \((AP_t)\), is the habitual domain at time \(t\) as to be described in section III. As in \((1)\), \(X_{t+\Delta t}\) not only depends on \(X_t\) but also on the other decision elements, \(F_n\), \(F_t\), \(D_n\), \(I_t\) as well as \(HD_t\).

Note that \(X_t\) and \(X_{t+\Delta t}\) can be set functions, and the difference between \(X_t\) and \(X_{t+\Delta t}\) would describe the changes due to time and situation. Also note that \(X_t\) and \(X_{t+\Delta t}\) can have different dimensionality.

Similarly, we can write the dynamic change of other parameters as follows:

\[
F_{t+\Delta t} = H(X_t, F_n, F_t, D_n, I_t, HD_t) \quad (2)
\]

\[
F_{t+\Delta t} = J(X_t, F_n, F_t, D_n, I_t, HD_t) \quad (3)
\]

\[
D_{t+\Delta t} = K(X_t, F_n, F_t, D_n, I_t, HD_t) \quad (4)
\]

\[
I_{t+\Delta t} = L(X_t, F_n, F_t, D_n, I_t, HD_t) \quad (5)
\]

Note, \((1) – (5)\) describe the fact that the decision elements (or parameters) not only vary with time, but also mutually interact with each other through time. For further discussion see Ch 7-8 of [11, 12].

**III. HABITUAL DOMAINS**

The collection of ideas and operators (including ways of perceiving, thinking, responding, acting, and memory) in our brain, together with their formation and dynamics, is called our habitual domains (HDS). Over time, unless extraordinary events occur or purposeful effort is exerted, our HDS will become stabilized within a certain domain. This phenomenon can be mathematically proved [1, 9].

Being aware of the habitual ways of our decision making is important for us to make better decisions and avoid costly mistakes. To better understand the concept of HD, let us briefly introduce the elements of HD, which are important parameters in the human behavioral systems.

HD at time \(t\), \(HD_t\), include the following four sub-concepts:

(i) **Potential domain**, designated by \(PD_t\), is the collection of all ideas and operators which can be potentially activated with respect to specific events or problems by one person or by one organization at time \(t\). In general, the larger the \(PD_t\), the more likely that a larger set of ideas and operators will be activated, holding all other things equal.

(ii) **Actual domain**, designated by \(AD_t\), is the collection of ideas and operators which are actually activated in our minds at time
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Note that not all the ideas and operators in the potential domain can be actually activated. Also note that the \( \text{AD}_t \) is a subset of the \( \text{PD}_t \), that is \( \text{AD}_t \subset \text{PD}_t \).

(iii) *Activation probability*, designated by \( \text{AP}_t \), is defined for each subset of \( \text{PD}_t \) and is the probability that a subset of \( \text{PD}_t \) is actually activated or is in \( \text{AD}_t \). For example, people who emphasize profit may be more likely to activate the idea of money, while people who study mathematics may be more likely to generate equations.

(iv) *Reachable domain*, designated by \( \text{RD}_t \), is the collection of ideas and operators which can be generated from a given set in an \( \text{AD}_t \). In general, the larger the idea set and/or operator set in \( \text{AD}_t \), the larger the \( \text{RD}_t \).

At any point in time, without specification, \( \text{HD}_t \) is the collection of the above four subsets. That is,

\[
\text{HD}_t = \{ \text{PD}_t, \text{AD}_t, \text{AP}_t, \text{RD}_t \}
\]

When there is no confusion, the subscript “\( t \)” may be dropped as to simplify the presentation. In general, the AD is only a small portion of the PD, and only a small portion of the AD is observable. This makes it very difficult for us to observe other people's HDs and/or even our own HDs. For more details, see [11-13].

**IV. COMPETENCE SETS AND DECISION BLINDS**

The study on competence set analysis began with Yu [10], as a derivative of HD theory. The competence set (CS) for a given decision problem is defined as a collection of ideas, knowledge, skills and resources for its effective solution. Such a set, like HD, implicitly contains PD, AD, RD, and AP as discussed in section III. When the decision maker thinks he/she has already acquired and mastered the CS as perceived, he/she would feel comfortable making the decision and/or undertaking the challenge. Anything or anyone, including a product or service that can release the pain, frustration and charge, has competence. Everyone, and every corporation, has its competence sets.

To analyze the competence sets of individuals or corporations, we can decompose the CS as follow:
\( C_{St} = (C_{St sol}^1, C_{St sol}^2, C_{St sol}^3, \ldots, C_{St sol}^n) \) 

where \( C_{St sol}^k \) denotes the \( k \)th item of the CS at time \( t \). Note that CS will be dynamically changed as time \( t \) goes by.

Because of HDs and being unaware of the decision parameters and their changing nature, people would easily have decision blinds or even get into decision traps. Let us denote the truly needed CS for solving problem \( E \) successfully by \( C_{St sol}^* (E) \) at time \( t \), and its perception by decision makers, by \( C_{St}^* (E) \). Then \( C_{St}^* (E) \setminus C_{St sol}^* (E) \) would be the decision blinds, the set of all the competences required but not seen by the decision makers at time \( t \). See the illustration of Figure 1. Note that the larger the decision blind is, the more likely decision makers might make dangerous mistakes.

Figure 1. Decision blinds

![Decision blinds illustration](image)

Figure 2. Decision blind reduces as we move our AD from A to B then to C

Usually, \( C_{St}^* (E) \) and \( C_{St sol}^* (E) \) can be changed with time. Suppose that \( C_{St sol}^* (E) \) is fixed or trapped in a certain domain and \( C_{St}^*(E) \) is large, then we tend to make mistake in decision and we are in a decision trap. Decision trap (i.e. \( C_{St sol}^* (E) \) is fixed, independent of \( t \)) can lead to dangerous mistake, especially when \( C_{St} (E) \) changes rapidly with time and \( C_{St} (E) \setminus C_{St sol}^* (E) \) becomes very large.

By changing our actual domains (ADs), we can change and expand our reachable domains (RDs). We can reduce decision blinds and/or avoid decision traps by systematically changing the ADs. For illustration, assume that \( C_{St} (E) \) and RDs are given, as depicted in Figure 2. Then as we move the AD from \( A \) to \( B \), then to \( C \), our decision blind reduces progressively from \( C_{St} (E) \setminus RD (A) \) to \( C_{St} (E) \setminus (RD (A) \cup RD (B)) \) then \( C_{St} (E) \setminus (RD (A) \cup RD (B) \cup RD (C)) \).
For challenging decision problem, we can treat the decision parameters as different points for ADs. Systematically moving over the parameters and pondering their possible RDs can expand our RDs for dealing with the challenging problems. As a consequence, $CS^*(E)$ is expanded and our decision blinds, $CS(E) \setminus CS^*(E)$, reduced. In additions, the HD tools [11-13] can work with the individual decision parameters as to reduce the decision blinds and avoid decision traps. They can expand and enrich our ADs and RDs and look into the depth of the PDs, they can also expand and enrich our perception on the decision problem and its related parameters.

V. INNOVATION DYNAMICS

According to the HD theory and CS analysis, all humans and things can release pains and frustrations for certain group of people at certain situations and time. Thus, all humans and things carry the competence (in broad sense, including skills, resources, functionalities, even attitudes). If we regard all humans and things as a set of different CSs, then producing new products or services can be regarded as a transformation of the existent CS to a new form of CS. Based on this, we could depict a comprehensive and integrated framework, called the Innovation Dynamics (see Figure 3), to help people understand corporate innovation and creation of maximal values for the targeted customers and themselves.

The dynamics can be interpreted clock-wise, according to the indices of Figure 3, as follows:
(i) According to HD Theory, when there exists unfavorable discrepancies between the current states and the ideal goals of individuals or organizations (for instance, the corporations are losing money instead of making money, or they are technologically behind, instead of ahead of the competitors), it will create charges which can prompt the individuals or corporations to work harder to reach their ideal goals.

(ii) The transformation of CSs will be presented in visible or invisible ways, which results in a new set of the products or services produced by the corporations.

(iii) The products or services produced by corporations must carry the capability to relieve / release the pain and frustration of targeted customers. Note that there are actual domains, reachable domains, and potential domains for the targeted customers, and for their pains, frustrations, and problems.

(iv) Besides discharge, corporations or

Figure 3. Innovation Dynamics
organizations can create charges to the targeted customers by means of marketing, advertisement or promotion, and vice versa.

(v) The targeted customers will experience the change of charges. When their pains and frustrations are relieved, the customers become happy. By their buying the products or services, the products and services create their value.

(vi) The value will be distributed to the participants such as employees, stakeholders, suppliers, society, etc. In addition, to gain the competitive edge, products and services have to be continuously upgraded and improved. The reinvestment therefore is needed in order to develop and produce new products and services.

In contrast to the clockwise cycle, the Innovation Dynamics can be interpreted counter-clockwise, according to the indexing of Figure 3, as follows:

(A) To create values, the corporations must consider who will be the targeted customers, and what kind of pain and frustration they have, both in actual and potential domains.

(B) In order to ease the pains and frustrations for the targeted customers, what products or services, in actual and potential domains, are needed? Competitiveness becomes an important issue in the final selection of the products and services to produce.

(C) How do the corporations transform their internal and external competence and resource to develop or provide the selected products and services effectively and efficiently?

(D) When the transformation of CSs succeeds, the corporation’s internal and external charge will be released, at least partially.

(E) New goals as to create new values can be reestablished. The innovation cycle : (A) \(\rightarrow\) (B) \(\rightarrow\) (C) \(\rightarrow\) (D) \(\rightarrow\) (E) \(\rightarrow\) (A) will go round and round.

The concept of Innovation Dynamics describes the dynamics of how to solve a set of problems with our existent or acquired competence (to relieve the pains or frustrations of targeted customers or decision makers at certain situations) as to create value, and how to distribute this created value so that we can continuously expand and enrich the CS to solve
more challenging problems and create more value. Observe that each links, clockwise or counterclockwise, in Figure 3 involves decision makings in changeable spaces.

VI. VERIFICATION

Let us consider the following two cases to verify the framework of Innovation Dynamics.

A. Case I: YouTube

At the end of 2006, a 1.5 year-old video sharing company, YouTube, was merged by Google, the well-known search engine, at the price of $1.65 billion. This high-profile event was the biggest merger case for Google at that time. It drew a great deal of discussion and attention.

The three YouTube founders originally intended to provide their product to eBay as a way to introduce auction products, in addition to pictures and text descriptions. The idea appeared to meet a demand, but never succeeded. They then extended their product to the PDs of potential users, and found there are a large number of people with a strong desire to express themselves to online friends. These desires in PDs were not discovered until YouTube dropped their original idea and explored the real need in the PDs of the potential customers.

From the initial garage venture to a website worth over US$1.6 billion, the growth and development of YouTube is a process of continuous integrating and transforming CSs. In the process, they released people’s potential pain and frustration by providing effective product and service that others could not, or would not. By doing so, they enhanced their corporate competiveness and used it to create value.

B. Case II: Wii

Nintendo started working in the game console industry in the 1970s, when there were not many design alternations for game consoles. Players must operate the gamepad with two hands, and they could only use their thumbs to control movement. Until 2006, Satoru Iwata, who had been the president of Nintendo for less than five years, led Nintendo to break the three-decade old design. Wii, with the simple creativity of “operate with one hand”, was born.

The appearance of Wii has created a new generation of games. It brings a new
entertainment experience, and the innovative interface of game control has successfully reduced the time needed for new players to learn how to play a game. The remote control is equipped with sound effects, vibrates and has orientation functionality. It allows players to simulate the behavior of real games and brings users an unprecedented gaming experience.

Nintendo had lost its leading position in the gaming industry before Wii entered into the market, which caused the company market share to fall behind. The Wii is Nintendo’s innovation breakthrough. Its innovation is not only in “subverting traditional design”, but more importantly, it satisfied the desire of people “wanting to experience realistic gaming” in PDs. In the past, the game console industry was always committed to pursuing exquisite graphics, sound and light effects, attempting to satisfy the desire of player. However, luxurious graphics, sound and light effects are the needs in the ADs for gamers (desires of audio and visual aspects). Allowing body movements and feeling the speed, direction or even power with the game are the strong needs hidden in the players’ PDs. By satisfying the needs in PDs, Wii recreated the interaction between gamers and games, which not only creates value for Nintendo, but also allows the company to regain its competitive advantage.

VII. CONCLUDING REMARKS

In this article, the concepts of decision making in changeable spaces, HDs, CS analysis and Innovation Dynamics and its verification are introduced. The activities over each link of the Innovation Dynamics involve decision making in changeable spaces. By examining the operations of each link in Innovation Dynamics, corporations can understand if each and all links are properly developed, so that they can continuously upgrade their products or services and maximally create value by releasing pains and frustrations for the customers in the PDs. The Innovation Dynamics can help them to be as successful and competitive as YouTube and Nintendo.

Many research problems remain open. For instances, how to systematically analyze the invisible potential domains as to find effective method to acquire, adjust and allocate resources
in potential domains; and how to effectively transform the hidden resources in potential domains into products/services to effectively release the pains and frustrations of the people concerned. Mathematical analysis for specific cases would be of great interest to study. These would bring value to practical business innovation and to academic research as well.

REFERENCES


