

# Wuity as Higher Cognition Combining Intuitive and Deliberate Judgments for Creativity —Analyzing Elon Musk’s Way to Innovate

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**Abstracts** Derived from unifying dual-process theories of cognitive psychology, we propose a new concept of deliberate intuition as a construct of higher-level cognition that integrates intuitive and deliberate judgments. We introduce “Wuity” cognition embedded into Chinese philosophy, medicine and practices, which is defined by the capability of deliberate intuition and intuitive insights, based on imagery reasoning and non-dualistic thinking and manifested as mindful observation and visual analogy. We develop a framework of three features of Wuity and six steps of Wuity-based innovation. As a case study illustrating our method, we analyze Elon Musk’s way to innovate and discuss common aspects of Wuity as a higher cognition and creative thinking way of innovators in East and West.

## 1 Introduction

Psychological and cognitive theories and management science enjoy the longevity of William James’s suggestion that human reasoning involves two distinct processing systems: one that is quick, effortless, associative, and intuitive; the other that is slow, effortful, analytic, and deliberate (Alter et al., 2007). Nisbett and his colleagues find that Westerners tend to engage in context-independent, analytic and conceptual processes by focusing on a salient object independently of its context, whereas Asians tend to engage in context-dependent, holistic and intuitive perceptual processes by attending to the relationship between the object and the context in which the object is situated (Peng & Nisbett, 1999; Nisbett, Peng, Choi, & Norenzayan, 2001).

A wealth of psychological and management research has been conducted in an effort to resolve the debate whether those two systems obey dual-processes theories or whether there is an overall framework of humans integrating the two conflicting ones. Bird (1988) claims that entrepreneurial intentions are structured by both rational/analytic thinking (goal-directed behavior) and holistic/intuitive thinking (vision). Evan and Stanovich hold a default-interventionist and parallel-competitive assumption, which means that intuitive (Type 1) answers are often prompted rapidly and with little effort when people are confronted with novel problems. Where they lack relevant experience, however, these answers may be biased, inappropriate and fail to meet the goals set. Thus reflective (Type 2) reasoning intervenes and replaces default intuition slowly and delicately (Evan & Stanovich, 2013; Thompson, 2009; Thompson, Turner, & Pennycock, 2011). Sowden, Pringle and Gabora (2015) propose that creative thinking may rest on the parallel and serial combination between type 1 and type 2. (Kruglanski & Gigerenzer, 2011) provide convergent arguments away from dual-processes theories and evidences for a unified theoretical approach to both intuitive and deliberate judgments. They propose that the very same rules can underlie both intuitive and deliberate judgments, and believe that deliberate judgments are not generally more accurate than intuitive judgments. Less effort can lead to higher accuracy.

The conceptual and empirical difficulties entailed by the partition between intuitive and deliberate judgments, and their alignment with multiple similar dichotomies have impeded a deeper examination of the psychology of judgment, it is therefore time to move beyond imprecise dualisms and toward

specific models of the judgmental process (Kruglanski & Gigerenzer, 2011). In this paper, we introduce a new concept which we term “Wuity” cognition, embedded into the context of Chinese philosophy. “Wuity” is the capability of developing sensible intuition into intuitive insights through imagining and reasoning based on imagery (image, mental imagery and natural/social phenomena) rather than logic, rooted in a non-dualistic opposite view of Daoism and Zen culture. We integrate research results in cognitive sciences to explore its role as a higher-level cognition to harmonize intuitive and analytic processes. We also provide evidence how the higher-level wuity cognition synthesizes deliberative intuition and visual analogy reasoning for creativity, through a six-step wuity-based innovation process model and a case study of Elon Musk’s innovation process.

## **2 Related Work**

### ***2.1 Higher cognition***

Cognition is the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses (Oxford dictionary, 2016). It encompasses processes such as knowledge, attention, memory and working memory, judgment and evaluation, reasoning and "computation", problem solving and decision making, comprehension and production of language. Human cognition is conscious and unconscious, concrete and abstract, as well as intuitive and conceptual. Cognitive processes use existing knowledge to generate new knowledge. A higher and creative cognition can bind and harmonize intuitive and delicate information processing, from a non-dualistic opposite view, as is held by Daoism which believes that the true nature of reality is non-dual (yang and yin interact with each other and create new insights), and all binary opposites are either unrealistic or inaccurate descriptions. Kruglanski and Gigerenzer (2011) propose that deliberation can become intuitive (intuitive deliberation), for example a novice piano player engaged in ten thousand hours of training would perform perfectly (assuming some talent). On the other hand, intuition can become deliberate (deliberate intuition), through training the mind to be attentive and through reasoning by imagery.

### ***2.2 Deliberate Intuition***

Francisco and Burnett (2008) propose deliberate intuition as the intentional engagement of intuitive skills in service of uncovering hidden relationships, ideas and insights to harmonize intuitive and deliberate information processing while generating creative changes. Here we would like to introduce two kinds of reflective and deliberate intuition as examples, featured by imagery-based reasoning, one is mindful observation and the other is visual analogy. Besides the two, there may be different types of mixtures of intuitive and deliberative judgments.

#### **2.2.1 Mindful Observation**

Mindfulness is a state of mind that permits insight, presence, and reflection, in which one focuses on experience in the present moment in a non-judgemental way (Kabat-Zinn, 1994; Marlatt & Kristeller, 1999). A non-judgemental way means suspension of existing experience and knowledge on the impact of observation. Mindfulness includes both formal type meditation practice (e.g., sitting meditation, walking meditation, and so on) and informal type mindful practice in everyday life (e.g., mindfulness of eating, mindfulness of driving, and so forth) (Kabat-Zinn, 1990). Dekeyser and colleagues (2008) point out four aspects of mindfulness: mindful observation, non-aversion, non-judgment, and letting go; Epstein (2003) thinks mindful practice includes core features: attentive observation, critical curiosity, “beginner’s mind” and presence. All descriptions of mindfulness emphasize the importance of observing, noticing, or attending to a variety of stimuli, including internal phenomena, such as bodily sensations, cognitions, and emotions, and external phenomena, such as sounds and smells (Dimidjian & Linehan, 2003b; Kabat-Zinn, 1990; Segal et al., 2002). Mindful observation means

observing and seeing with awareness, which is the careful attending to internal and external phenomena (e.g., thoughts, emotions, sounds, smells, or proprioceptive sensations) (Dimidjian & Linehan, 2003; Linehan, 1993). As Schwartz et al. (2005) state, 'Perhaps the essential characteristic of mindful observation is that you are just watching, observing all facts, both inner and outer, very calmly, clearly and closely'. This implies a detachment from the 'things' being observed. Learning, therefore, is not solely a matter of what one knows, but also of whom learners become (Borgo 2007; Pavlovich & Krahnke, 2012).

Scientific observation usually refers to the observation from binary opposing views, or outward observation, in which subjective observers are separated from the object observed. The effects of observation depend on certain tools, such as eyes, telescopes or microscopes to observe the external world. Observers have to maintain an objective attitude to avoid any personal subjective assumptions affecting results. The limitation of this approach is that it can't apply to observing a person's mind and sub-consciousness. On the contrary, mindful observation is from the non-binary opposing view, also known as inward observation in Daoism or Vipassana (Insight Meditation) in Buddhist tradition, emphasizing that the observer and the observed are whole or unified. There is no need to distinguish between subjects and objects, observers have to carefully perceive and scan what is observing or seeing intuitively to keep a seamless observation and achieve deep understandings of relationships of overall structure and detailed parts. The cognitive results depend on the status of the observer, just as revealed by the principle of physical uncertainty. So the observer makes himself/herself to be an accurate and reliable observation tool, just as a mirror, through training their mind, reflecting images or phenomena or mental images by imagery-based thinking, and eliminating the influence of the subjective status. Mindful observation is not against scientific observation, whose purpose is to find undiscovered parts that have never been attended to with careful awareness and non-judgment. Rather it complements or hints at the findings of scientific observation.

### **2.2.2 Visual Analogy**

Visual analogy is an analogical reasoning process based on the similarity and connection among dynamic perceptual imagery and mental images. Visual mental images have led many people to liken it to "seeing with the mind's eye" (Pylyshyn, 1973); however, for a long time researchers have failed to evidence its role in information processing and imagery-based reasoning, and hold an argument that all mental activity relies on symbolic, propositional representations, and the experience of imagery is like "the heat thrown off". Based on new findings from neuroscience many researchers have revived the idea that mental imagery involves a special format of thought, one that is pictorial in nature (Pylyshyn, 2003). In 2011, Lewis and his colleagues (2011) successfully integrated visual mental images and visual percepts in two experiments, which provide new evidence for imagery-based thinking as depictive representations. Goldschmidt (2001) proposes that the use of visual analogy in problem solving is an example of similarity-based reasoning, cognitively facilitated by imagistic operations. These findings provide evidence for the hypothesis that certain analogical reasoning processes can be imagery based. Wang and Lawson (2015) show a dual representation position that takes visual mental imagery as a key representational format, suggesting complementary and integrating roles for verbal and pictorial representations in accounting for certain cognitive phenomena.

A faculty for analogical reasoning is an innate part of human cognition, while the concept of a sound, inferentially useful analogy is universal. Therefore visual analogy and metaphors have been used at different points in the history of Western scientific thought (Gentner and Jeziorski, 1993). The Chinese Daoism Schemas of Yin and Yang, Five Agents and Ba Gua are all visual analogies based on non-dualistic thinking. Analogical reasoning can be used to classify two or more types of objects in terms of structure, function, causality, symmetry, and model, among others. Analogical reasoning is a kind of probabilistic reasoning, the similarity or connection between objects makes it possible to obtain the correct conclusion while the difference between them leads to the conclusion with probabilities. Normal analogy reasoning is a kind of reasoning method developed by conceptual logic, its intermediary for reasoning is attributes, with strict connotation and extension. However the intermediary of visual analogy is images, including both images of objects or phenomena and mental images. With multidimensional features and contents of images, contrary to a single attribute of conceptual logic, connections between two analogical images are multidimensional, dynamic and easy to imagine. Visual analogy is often applied to solve non-routine problems. The type of analogy is known as 'between-domain', where the analogical source, and the target problem belong to different and distant domains. In cases in which source and target are embedded in the same or very close

domain, the analogy is called ‘within-domain’ (Casakin, 2004). Dejong (1989) claims that within-domain analogies are mainly based on surface similarities, and therefore are easier to establish. Vosniadou (1989) proves that successful analogical reasoning can be employed between any two objects that belong to the same domain provided it involves transferring an explanatory structure from one item to the other. Visual displays belonging to a remote domain (between-domain sources). Researchers such as Gentner (1989), Holyaok and Thagard (1989), and Keane (1988) have found that novices and experts show different preference in establishing structural analogies, which lead to different results.

### 3 “Wuity” cognition

Informally, Wuity cognition is embedded into Chinese philosophy, medicine and practices, which is defined by deliberate intuition and intuitive insights, based on imagery reasoning and non-dualistic thinking, the core of which is the “Qu Xiang Bi Lei” cognitive model (Zhang & Chen, 1991; Fengli, 2010), which manifests as mindful observation and visual analogy.

#### 3.1 Definition

Wuity (悟 *wù* <sup>intuitive insights</sup> 性 *xìng* <sup>nature</sup>) is the capability of developing sensible intuition into intuitive insights based on non-binary opposing views and visual thinking, relative to achieving a deep understanding, higher cognition and insights into essence through intuitive perceiving, observing with awareness, visual analyzing and knowing previously undiscovered relationships and opportunities in the process of cognitive dynamics. It emphasizes returning to the heart, going back to the origin of the problem and putting aside the dualistic opposition (for example yin and yang, black and white). It has its base on intuition, imagination, metaphor, and analogy reasoning. Wuity cognition featured by the “Qu Xiang Bi Lei” cognitive model is the collective subconscious of Chinese people. It is rooted in the traditional culture and religions of Daoism, Zen, and Confucianism, but it transcends the religious meaning of mindfulness or Vipassana. It evolved into the “Qu Xiang Bi Lei” cognitive model and has been applied to philosophy, literature, medicine, mathematics, engineering, agriculture and so on, since Daoist philosopher Zhuangzi first mentioned Wuity 2000 years ago (Zhuangzi 21, Tianzifang, line 33). Yang Yi believes that Wuity is the advantage of the Chinese traditional way of thinking; Oriental Wuity and Western rationality are two important achievements in the history of human thought, they can compare with and complement each other (Yang Yi, 2008).

#### 3.2 Features of Wuity cognition

Based on earlier work, adopting the case study method of management science in the context of a Chinese aerospace innovation team, we propose a framework of Wuity thinking consisting of four elements and a Wuity-based innovation process with six specific steps. From a cognitive perspective, we find that Wuity thinking helps innovators to distill insights into essence through the process of entering the deliberate intuition thinking process after getting stuck in analytic thinking, and thus gaining innovative solutions through rational reconstruction with a rigorous scientific methodology (Wang and Li, 2017).

Wuity cognition is composed of four characteristics, including zero mentality to put down the bound of previous experience and knowledge, the non-binary mindful observation method, between domain inspiration by visual analogy and insights into essence. Mindful observation, and visual analogy, as parts of “Qu Xiang Bi Lei” detailed above, are regarded as the core of Wuity cognition. We now further describe the other two parts of Wuity thinking.

##### 3.2.1 Zero Mentality

Letting go, or zero mentality or beginner's mind or "empty cup" mentality, is the most familiar and convenient strategy to prepare the mind. It is the preparation for mindful observation. If an innovator is getting stuck in the routine thinking model, past hurts and old injustices might prevent her/him from observing clearly and attentively, s/he would be unable to move forward or to experience joy. A let-go attitude and behavior might lead to a radical reboot to get past yesterday's thinking (Smallwood and O'Connor, 2011; Smallwood et al., 2013).

### 3.2.2 "Qu Xiang Bi Lei" cognitive model

"Qu Xiang Bi Lei" means adopting dynamic images and visual analogizing/metaphoring between images of different domains. "Qu" means "adopting or selecting"; "Xiang"/ "象 $x\grave{a}ng$ " is a general term for images, mental images, and phenomena, which means xiang-based thinking or imagery-based thinking; "Bi Lei" means reasoning by visual analogy or natural metaphors (Wang, 1997). It is a kind of cognitive thinking model used by the ancient Chinese to study the laws of nature, which is based on the similarity of different images and the leveraging of mindful observation and visual analogy/metaphors. As a core feature of classical Chinese visual thinking, these images are dynamic and changeable, resulting from mindful observation at different time points in the process of cognitive dynamics. There is also a similar connection along the evolution of different images. These forms of images are not only the images of phenomena seen by the eye, but also the mental images that reflect what is perceived, even a grand or whole image as a rule or law. The purpose of adopting dynamic images is to realize the transformation from what has been seen to what is to be known, from the surface to the nature. Visual analogizing is based on the dynamic images to illustrate not the superficial association between two types of those images, but the deep level association or innate relationship, even if these connections or similarities are not off-the-shelf or ever used by others, but alien linkages that have not been discovered or explored until now.

It was through the "Qu Xiang Bi Lei" cognitive model that China's ancient people mastered the laws of nature, thus creating the important structural relationship diagram of the yin and yang, five agents, Ba Gua, and then applying them to multi-disciplines such as ancient literature, arts, Chinese medicine, geography, mathematics, chemistry, engineering and other fields, embodied in the traditional culture of Taoism, Confucianism and Zen culture and religions and Gong Fu such as Taiji. Once good "Qu Xiang Bi Lei" is found, confusion and contradiction caused by superficial observation will be swept away, and one will enter a "transparent" state with an enlightened mind. Its purpose is to realize the transformation of something seen into something known, fuzzy intuitive insights into a clear theoretical concept (Wang and Liu, 1993).

### 3.2.3 Gaining insight

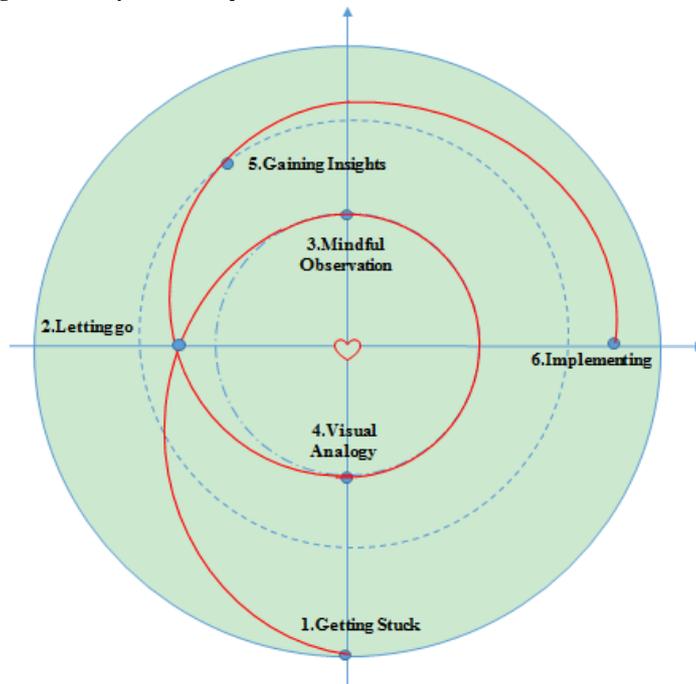
Gaining a clear and deep insight is the most productive result of Wuity thinking. Once good analogy between different domains is found, confusion and contradiction caused by superficial observation will be swept away, and one will enter a transparent state with a clear mind and insights into essence. The study of insights started in the 1970s as a branch of cognitive psychology. Researchers pointed out that people tend to encounter an obstacle, commonly known as "getting stuck" on their way to insight. At the same time, insight is considered to be gained through a cognitive restructuring process, which is the only way to the right answer (Epstein et al., 1984). We provide evidence that insights are gained through putting full attention to the target, developing visual analogy, and mapping integration between two domains: one domain is the resource domain, the other is the target domain, the relationship between them is called within-domain or between-domain. If an innovator could find good analogies from unrelated between-domain and build undiscovered relationships between them, the probability of gaining sudden insight is much higher. Especially, innovators build visual analogies between the knowledge world and the action world.

## 3.3 Six Steps of Wuity-based innovation

We proposed the framework of the Wuity-based innovation process consisting six steps and adopted the case study method to verify it on the team level in the China aerospace context (Wang and Li., 2017). The six steps include: (1) getting stuck--in the thematic knowledge domain; (2) letting go--

returning to the original source as the restarting point; (3) mindful observation--toward getting a whole picture of the associated objects; (4) visual analogy-- triggering inspirations of the underlying link between the two mapping domains; (5) gaining insight--clear and deep, into the complex context, and (6) implementing--obtaining innovative solutions based on rational reconstruction with a rigorous scientific methodology (figure 1).

Fig.1. Six Steps of Wuity-based innovation



## 4. Case Study

### 4.1 Case Study Method

We illustrate the Wuity-based innovation method in a case study related to Western innovators. Our goal is to verify the applicability of the theoretical model and provide a relevant competitive interpretation through learning transfer theory (Simmons, 2016). Since the framework of Wuity cognition is rooted in Eastern culture, we propose to make it clear in a case study to verify it in the Western innovation context (Eisenhardt, 1989; Eisenhardt & Graebner, 2007). We chose the case of Elon Musk, because it is highly enlightening and provides a rare opportunity to light up and expand the relation and logic between different constructs (Siggelkow, 2007). We provide self-sufficiency in theoretical elaboration to clarify all the constructs mentioned. At the same time, we select the data most relevant to theoretical constructs in the case study and offer closely related details so as to provide readers with a concrete and convincing example of every construct.

### 4.2 Data Sources

Elon Musk is known as a “real-world version of Iron Man”, the most innovative businessman after Steve Jobs and a “Da Vinci style” Renaissance generalist. He is currently the CEO / Chairman of six state-of-the-art technology companies such as Space X, Tesla electric vehicle, Solar City, Hyper Loop, Open AI and Neurolink as well as Tesla's main product designer. His innovative history is of an

“American dream”, illustrating an entrepreneur's adventurous spirit and the hard work of the engineer. Our study is based on the following three kinds of data: (1) Interview videos. We watched many interviews and selected chats related to research, for example interviews of Tiecon Live Studios TiEcon2008, The Future Of Energy And Transport, Qsinghua University Interview and Timothy Kenny. Modeling Report. (2) Books. For instance “Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future” by Ashlee Vance, another is “Elon Musk: A Biography of Business, Success and Entrepreneurship (Tesla, SpaceX, Billionaire)” by B Storm. (3) Media papers and websites. Some articles, reports and e-courses related to Elon Musk and his companies and so have been retrieved and studied .

### 4.3 Case Analysis

In this case study, we analyze those data points in the spatial and temporal dimensions. On one hand, we find four metaphors that Elon Musk mentioned and that are cited by media frequently, and compare them with the four features of Wuity cognition. On the other hand, we sorted out the process that Elon Musk developed when experimenting with the Space X rockets and motors and analyze it from the six steps view.

#### 4.3.1 Elon Musk's Four Metaphors

##### (1) *Glasses + abyss vs. zero mentality*

Elon Musk said, “A friend of mine has a saying: ‘Starting a company is like chewing glass and staring into the abyss.’ You have to do lots of things you don’t like.”(Musk interview, 2017) “Failure is an option here. If things are not failing, you are not innovating enough; Optimism, pessimism; we’re going to make it happen. As God is my bloody witness, I’m hell-bent on making it work ” (Zachary, 2016). Judging from those quotes, it seems that Musk knows how to keep a beginner’s mind and letting go pessimistic emotion. His most traumatic years were around 2008-2009; he desperately needed financing for electric car venture Tesla during the global economic recession. “It was the last hour of the last day that financing needed to be closed, or the company would go bankrupt,” he said (Musk interview, 2012.). The stock market had gone into a free fall, and investors kept changing the terms. Musk took over the reins as CEO and funneled millions of his own money into Tesla. He not only is staying in the mode of continuous exploration, but also always starts again after a failure, without being interrupted by his negative emotions. In 2008 after the first three rocket tests failed, he faced the risk of bankruptcy, however he persisted on the last day and never gave up, reviving the raising of funds and launched successfully in the fourth rocket test.

##### (2) *knowledge as a semantic tree vs. mindful observation*

In Musk's Reddit AMA interview, when answering how he learned so much so fast and took it (learning) to a whole new level, Musk wrote, “It is important to view knowledge as sort of a semantic tree — make sure you understand the fundamental principles, i.e. the trunk and big branches, before you get into the leaves/details or there is nothing for them to hang onto.”(Musk interview, 2015b) As a cross-spanning expert-generalist, Elon Musk enjoys reading, “his ability to master several different fields isn’t magic. At first, Musk’s reading spanned science fiction, philosophy, religion, programming, and biographies of scientists, engineers, and entrepreneurs. As he got older, his reading and career interests spread to physics, engineering, product design, business, technology, and energy. This thirst for knowledge allowed him to be exposed to a variety of subjects he had never necessarily learned about in school.”(Simmons,2016) With the focus of his interests changing and experiencing new business practices, Musk constantly obtains new concepts of different disciplines of the knowledge world, it is mindful observation strategy that helps him arrange the priority sequence between all kinds of knowledge based on sematic understanding and sense-making in a deliberate and intuitive way, he builds a dynamic and holistic semantic tree of different disciplines, which reflects his own knowledge view as a knowledge map. He builds an integrated view of his knowledge tree intuitively by observing his own mind and sub-consciousness inwardly.

##### (3) *cross-specialization connection vs. visual analogy*

Facing problem-solving in the business world, Elon Musk did not copy routines that others made, but broke the path dependence, gained inspiration through creatively connecting two domains and

observed them together as a whole. He could then visually analyze the advantages of one domain and disadvantages of the other domain, and thus found insightful new innovative opportunity that had never been discovered before. When Elon Musk was asked “if time could be reversed how will you redesign and select your career, and your life to maximum and to perfect, and what’s your advice to students in Tsinghua University?” he answered, “I think it is a good idea to study a broad range of subjects, a lot of innovation comes through cross-specialization from one area to another, because increasingly as the knowledge basis grows we become quite captured in the siloes of our knowledge. Maybe someone is specialized in one area or another area, and if you can combine these specialties and create some composites of the parts, there are a lot of innovation opportunities by doing that. I think to have general knowledge of domains is very important. Even specializing in two areas, I think there are great opportunities. If you look and see what has been done in one domain, and what parts of that domain could be transferable to another domain. If you can combine them, that would be quite helpful.”(Musk interview, 2015a)

#### *(4) first principle vs. insights into essence*

Elon Musk mentioned the first principle several times in different circumstances. "If we put in the time and learn core concepts across fields and always relate those concepts back to our life and the world, transferring between areas becomes much easier and faster. As we build up a reservoir of 'first principles' and associate those principles with different fields, we suddenly gain the superpower of being able to go into a new field we've never learned before, and quickly make unique contributions."(Musk interview, 2015a) It was in a brainstorming session that he suddenly realized that the first principle would help him solve the question of rocket improvement and low cost strategy, he disclosed it in “The Future Of Energy And Transport interview” (Musk interview, 2012). Actually, the first principle is insight that he gained through connecting the two domains of the knowledge world and the action world. At the same time, he applied this insight to provide rules both for communicating with employees and for logical analytic thinking in the business world. To resume, the first principle is multifunctional, it is an insightful common principle that could be applied to the knowledge world as the premise of logical analysis and to the action world as a simple rule to communicate with people (Kruglanski and Gigerenzer, 2011; Bingham and Eisenhardt, 2011).

### **4.3.2 The Process of Innovation in Developing Space X**

In this section we analyze the process that Elon Musk developed to experiment with the Space X rockets and motors and analyze them using the six steps view. His innovation process is divided into six steps:

#### *(1) getting stuck*

“Unwilling to pay what U.S. rocket companies were charging, Elon Musk made three trips to Russia and tried to buy a refurbished Dnepr missile, but found deal-making in the wild west of Russian capitalism too risky financially.”(Chaikin,2012)

#### *(2) zero mentality*

When the Russians refused to negotiate, Elon decided to build the rocket himself - the modern Falcon 9 in 2002 (Cantrell, 2015). Robert Zubrin, president of Pioneer Astronautics said “When I first met him in 2001, he knew absolutely nothing about rockets, though he clearly had a scientific mind, By 2004, he had learned a fair amount, and by 2007 he knew everything” (Hall et al.,2014). “Musk also keeps a small collection of books on his desk--a sort of autodidact's guide on how to build rockets: Huzel and Huang on the fundamentals of liquid propellants, Sutton and Biblarz on propulsion elements, J.E. Gordon's Structures: Or Why Things Don't Fall Down.”(Kluger, 2012).

#### *(3) mindful observation*

“Elon can get to near mastery level on a subject in a pretty short amount of time through sheer will. What he's very good at is processing complex information for a wide variety of fields very well.” “There's little in his educational background that should have made him ready to make cars and rockets. He largely learned aerospace by reading textbooks given to him by a friend and interviewing experts and his own employees. He does - and this is true - help design the rockets” (Vance, 2016).

#### *(4)visual analogy*

Elon said, “If we put in the time and learn core concepts across fields and always relate those concepts back to our life and the world, transferring between areas becomes much easier and faster”. “I think it

is a good idea to study a broad range of subjects, a lot of innovations come through cross-specialization from one area to another, because increasingly as a knowledge basis grows we become quite adept through the siloes in our knowledge. I think to have general knowledge of domains is very important. Even specializing in two areas, I think there are great opportunities.” (Musk interview, 2015a)

*(5) gaining insight*

“For example with rockets and cars, the auto industry is very good at producing large complex mechanical objects at low cost. It is remarkable how little the car costs this way, and applying those manufacturing technologies to rocketry is very helpful. Going the other direction, rocketry is very good at making things very light. Because if it is not this way, it could not be sent to the orbit. So if you apply those techniques to cars, you can help with making lighter cars, and it allows cars have greater range. So this is an example of cross-specialization” (Musk interview, 2015a).

*(6) implementing*

For the rocket industry, Elon Musk combined the advantages of low-cost pipelines and thrust-adjustable engines in the automotive industry with the high cost and non-reusable disadvantages of the rocket industry.. First, the Space X Company took the lead in the field of aerospace in assembly line production mode. Second, Space X Falcon Rockets achieved a smooth landing and a successful recovery, the “gray falcon” rocket engine is the key to success(Musk interview, 2015a; Tesla news, 2015).

## 5. Discussion and Conclusions

Applying the case study method, we find that Elon Musk’s four innovation metaphors of “glasses+abyss”, “knowledge as a semantic tree”, “cross-specialization connection” and “first principle” correspond to four features of Wuity thinking (zero mentality, mindful observation, visual analogy, and insights into essence). His innovative process of developing and testing Space X corresponds to the six steps of Wuity-based innovation. Wuity-based innovation is used to interpret Elon Musk’s way to innovate through learning transfer (Simmons, 2016). Wang Shuren believe that, imagery-based thinking and the Wuity method are the source of original innovation, to innovate is to break the bondage of conceptual thinking, return to the original and natural thinking (Wang, 2006; 2012). We have shown that Wuity is a way to combine common cognition and creative thinking of innovators in East and West, although more discussion and rigorous empirical studies are needed in the future.

From the perspective of unifying dual-processes theories of cognitive psychology, we proposed a new concept of deliberate intuition as higher-level cognition of integrating intuitive and deliberate judgments, and introduced Wuity cognition derived from the context of Chinese culture. Wuity is a type of deliberate intuition and intuitive insights manifested as mindful observation and visual analogy strategy and based on imagery reasoning and a non-dualistic view. We used the framework of the four features of Wuity and the six steps of Wuity-based innovation adopting the case study methodology to illustrate Elon Musk’s way to innovate.

## Reference

1. Baer, R.A., Smith, G.T. and Allen, K.B., 2004. Assessment of mindfulness by self-report: The Kentucky Inventory of Mindfulness Skills. *Assessment*, 11(3), pp.191-206.
2. Bingham, C.B. and Eisenhardt, K.M., 2011. Rational heuristics: the ‘simple rules’ that strategists learn from process experience. *Strategic Management Journal*, 32(13), pp.1437-1464.
3. Bird, B., 1988. Implementing entrepreneurial ideas: The case for intention. *Academy of management Review*, 13(3), pp.442-453.
4. Borst, G. and Kosslyn, S.M., 2011. Integrating visual mental images and visual percepts: new evidence for depictive representations. *Psychological Research*, 75(4), pp.259-271.

5. Cantrell, J., 2015. Why did Elon Musk ask Jim Cantrell and Adeo Ressi, in particular, to travel to Russia with him in 2001? <https://www.quora.com/Why-did-Elon-Musk-ask-Jim-Cantrell-and-Adeo-Ressi-in-particular-to-travel-to-Russia-with-him-in-2001>[2017-6-10].
6. Casakin, H., 2004. Visual analogy as a cognitive strategy in the design process: Expert versus novice performance. *Journal of Design Research*, 4(2), p.124-141.
7. Chaikin , A. Is SpaceX Changing the Rocket Equation? *Air & Space Magazine*, Januray 2012. <http://www.airspacemag.com/space/is-spacex-changing-the-rocket-equation-132285884/>[2017-7-1]
8. Clement, J.J., 2004, January. Imagistic processes in analogical reasoning: Conserving transformations and dual simulations. In *Proceedings of the Cognitive Science Society* (Vol. 26, No. 26).
9. Cognition. Reference.(n.d.) In. *Oxford dictionary*[online]Oxford Press: Available at: <https://en.oxforddictionaries.com/definition/cognition> [Accessed 4 Feb. 2016]
10. Dekeyser, M., Raes, F., Leijssen, M., Leysen, S. and Dewulf, D., 2008. Mindfulness skills and interpersonal behaviour. *Personality and Individual Differences*, 44(5), pp.1235-1245.
11. Dimidjian, S. and Linehan, M.M., 2003. Defining an agenda for future research on the clinical application of mindfulness practice. *Clinical Psychology: Science and Practice*, 10(2), pp.166-171.
12. Epstein, R.M., 2003. Mindful practice in action (I): Technical competence, evidence-based medicine, and relationship-centered care. *Families, Systems, & Health*, 21(1), pp.1-9.
13. Evans, J.S.B. and Stanovich, K.E., 2013. Dual-process theories of higher cognition: Advancing the debate. *Perspectives on psychological science*, 8(3), pp.223-241.
14. Fengli L.,2010. Metaphor, Qu-Xiang Bi--Lei and Chinese Medicine. *The Way of Thinking: Theory, Methodology and Structure of Traditional Chinese Medicine*, 63-88.
15. Francisco, J.M. and Burnett, C.A., 2008. Deliberate intuition: giving intuitive insights their rightful place in the creative problem solving thinking skills model, pp.236-253. In *Creativity and Innovation* Lewis, K.J., *Management Journal Conference*.
16. Gentner, D ., Jeziorski, M . (1993) . The shift from metaphor to analogy in western science . In A . Ortony (Ed .), *Metaphor and Thought* (2nd ed) (pp . 447-480) . Cambridge, England : Cambridge University Press .
17. Gavetti, G. and Rivkin, J.W., 2005. How strategists really think. *Harvard Business Review*, 83(4), pp.54-63.
18. Goldschmidt, G., 2001. Visual analogy: A strategy for design reasoning and learning. *Design knowing and learning: Cognition in design education*, pp.199-220.
19. Habermas, J., 1992. *Postmetaphysical Thinking: Philosophical Essays*, trans. William Mark Hohengarten. Cambridge, Mass.: MIT Press.
20. Hull D., News B. and May P., 2014. Rocket Man: The otherworldly ambitions of Elon Musk. <http://www.mercurynews.com/2014/04/14/rocket-man-the-otherworldly-ambitions-of-elon-musk/> [2017-5-28].
21. Kruglanski, A.W. and Gigerenzer, G., 2011. Intuitive and deliberate judgments are based on common principles. *Psychological review*, 118(1), pp.97-109.
22. Kluger, J. , 2012. Rocket Man: Billionaire Elon Musk is getting America back in the space game. <http://content.time.com/time/subscriber/article/0,33009,2116714-2,00.html>[2017-5-20].
23. Musk E. Interview, 2015a. Qing Hua University China Interview.<https://www.tesla.cn/videos/dialogue-qianyingyi-elon-full-1022>[2017-5-23].
24. Musk E. review, 2015b. Knowledge as a semantic tree, [https://www.reddit.com/r/IAmA/comments/2rgsan/i\\_am\\_elon\\_musk\\_ceocto\\_of\\_a\\_rocket\\_company\\_ama/](https://www.reddit.com/r/IAmA/comments/2rgsan/i_am_elon_musk_ceocto_of_a_rocket_company_ama/)[2017-6-20].
25. Musk E. Interview, 2017. Elon Musk on How To Start Up A Business. <https://www.youtube.com/watch?v=gg23Y9Ua4qE>[2017-4-10].
26. Nisbett, R.E., Peng, K., Choi, I. and Norenzayan, A., 2001. Culture and systems of thought: holistic versus analytic cognition. *Psychological review*, 108(2), pp.291-310.

27. Pavlovich, K. and Krahnke, K., 2012. Empathy, connectedness and organisation. *Journal of business ethics*, 105(1), pp.131-137.
28. Pylyshyn, Z.W., 1973. What the mind's eye tells the mind's brain: A critique of mental imagery. *Psychological bulletin*, 80(1), pp.1-12,164.
29. Pylyshyn, Z., 2003. Return of the mental image: are there really pictures in the brain?. *Trends in cognitive sciences*, 7(3), pp.113-118.
30. Ren, J., Huang, Z., Luo, J., Wei, G., Ying, X., Ding, Z., Wu, Y. and Luo, F., 2011. Meditation promotes insightful problem-solving by keeping people in a mindful and alert conscious state. *Science China Life Sciences*, 54(10), pp.961-965.
31. Simmons M., 2016 .How Elon Musk Learns Faster And Better Than Everyone Else. [https://medium.com/@michaeldsimmons/how-elon-musk-learns-faster-and-better-than-everyone-else-104806b23df8#.9kjo7z3x9\[2017-7-20\]](https://medium.com/@michaeldsimmons/how-elon-musk-learns-faster-and-better-than-everyone-else-104806b23df8#.9kjo7z3x9[2017-7-20]).
32. Smallwood, J., & O'Connor, R. C. (2011). Imprisoned by the past: unhappy moods lead to a retrospective bias to mind wandering. *Cognition & Emotion*, 25(8), 1481-1490.
33. Smallwood, J., Ruby, F. J., & Singer, T. (2013). Letting go of the present: mind-wandering is associated with reduced delay discounting. *Consciousness and cognition*, 22(1), 1-7.
34. Tesla News, 2015. [https://www.tesla.cn/en/node/23354\[2017-4-3\]](https://www.tesla.cn/en/node/23354[2017-4-3]).
35. Vance, A., 2016. Is Elon Musk an expert generalist or specialist? [https://www.quora.com/Is-Elon-Musk-an-expert-generalist-or-specialist.\[2017-7-26\]](https://www.quora.com/Is-Elon-Musk-an-expert-generalist-or-specialist.[2017-7-26]).
36. Vance, A., 2017. *Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future*.
37. Wang, L. and Lawson, M.J., 2015. Visual Mental Imagery: A Key Representational Format. In *Transforming the Future of Learning with Educational Research* (pp. 36-50). IGI Global.
38. Wang Q. and Liu G., 1993.Chinese traditional abstract thinking from Chinese medicine adopting "xiang". *Journal of Philosophy*, 1993 (4): 45 - 50.
39. Wang Q., 1997. The essence and significance of "Qu Xiang Bi Lei" in Chinese traditional science. *History of Natural Science*, 16 (4), 297-303.
40. Wang S., Li M. *Percept Zhuangzi with intuitive Wuity: From Xiang thinking perspective*. Nanjing: Jiangsu People's Publishing House, 2006.
41. Wang S.. *Return to the original thinking - The Wisdom of China from Xiang thinking perspective*. Nanjing: Jiangsu People's Publishing House, 2012.
42. Wang, X. and Li, P.P., 2017. A Conceptual Framework of “Wu”-based Innovation at the Team Level: A Case Study on Indigenous Innovation in the Context of Aerospace Projects. *Foreign Economy and Management*, 39(3), pp.3-23.
43. Xiaogan, L., & Liu, X. ,2003. *Classifying the Zhuangzi chapters* (No. 65). University of Michigan Center for chinese.
44. Yang Yi, 2008. *The general theory of sentiment and wuity*. Beijing: People's Publishing House.
45. Zachary K.D., 2016. *Elon Musk’s Best Quotes on Business & Innovation*. [https://elonmusknews.org/blog/elon-musk-business-innovation-quotes\[2017-7-20\]](https://elonmusknews.org/blog/elon-musk-business-innovation-quotes[2017-7-20]).
46. Zhang D.N. and Cheng Z. Y. ,1991. *The preference of Chinese Thinking*, Beijing: China Social Sciences Press.