AN INSTINCT APPROACH TO DESIGN

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ABSTRACT

The word “Design” is used in many ways. But most of them consider it from the standpoint of artificial or man-made. In other words, as “Human Intelligence”, But we should remember we are born to “Design”. That is “Instinct”. We are born with instinct to survive. “Instint” is “Natural Intelligence”. “Instinct” plays an important role for making decisions. In decision making, we need to prioritze them. If the first one fails to satisfy our expectation, we take the next one. But our world is increasing complexity and complicatedness, and our bodies and movements are different from person to person. To cope with such increasing diversification, “Instinct” is calling for support. Therefore,Mahalanobis Distance-Pattern (MDP) approach is proposed in this paper as one of the tools to support our “Instinct”. MDP combines ordinal Mahalanobis Distance and pattern which is a non-verbal communication tool.

Keywords: Bio-inspired design / biomimetics, Creativity, Decision making, Design methods, Systems Engineering (SE)

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1 INTRODUCTION

The word “Design” is used in many ways. But most of them consider it from the standpoint of human. But we should remember we are born to design. That is “Instinct”. We are born with instinct, so we can survive. Instint is our natural intelligence. Most designs, on the other hand is human intelligence. It is pointed out in this paper how instinct plays an important role for making decisions. Decision making is an activity of strategy. We should consider What and Why. We need to find our goal. And we need to prioritze them. If the first strategy one fails to satisfy our expectation, then we take up the next one. Thus, ordinal scale comes into play. The rapid progress of techology brought us the Industrial Society and it introduced “Division of Labor” and we started to work for others. In other words, we started to work for external rewards.We forgot to work for ourselves.

Engineering started to make our dreams come true. Humans live for tomorrow. Animals, however, live for now. But the Industrial Society is the world of now. And current computing is based on 0-1 basis, i.e., it is preocessed on cardinal basis. To put it another way, our world has been Euclidean. It requires orthonormality and interval scale with unis. This way, we can evaluate “Value” of products quantitvely and objectively. But engineering is emotionl. What matters is “Self”. The Industrial Society is getting close to its ceiling so now is time to design and create a next society. We are getting back to the “Self” society. As we are different from person to person, our life varies individually. And our daily life changes continuously. Still, we can enjoy our daily life. “Instinct” provides us with an excellent guideline what decision and action we should take.

Thus, “Instinct” provides us with the holistic view of the Real World and help us make decisions. But our world is increasing complexity and complicatedness. So, “Instinct” is calling for support. Malahanobis Distance-Pattern (MDP) approach is proposed in this paper as one of the tools to achieve this purpose.

2 HUMAN NEEDS AND DESIGN

Abraham Maslow published a paper “A Theory of Human Motivation” in 1943 and made human needs clear (Maslow, 1943). And later in 1954, he published a book “Motivation and Personality” (Maslow,1954). He noted that our needs start from satisfying the material needs. We need food to survive and we need to protect ourselves from the outer world. These needs are the same as those of animals. But over time, human needs shift from material to mental and our final need is Self-Actualization. In short, animals live for now, but humans live for tomorrow. We would like to make our dreams come true. That is Engineering (Figure 1).

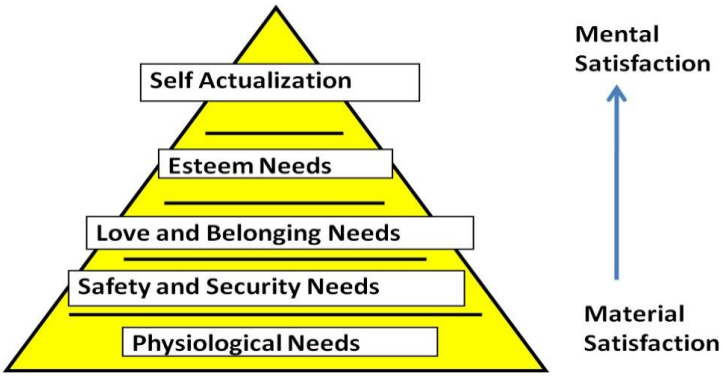

Figure 1. Maslow's human needs

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Edward Deci and Richard Ryan proposed Self-Determination Theory and made it clear that we get the maximum happiness and the feeling of achievement when we do the job internally motivated and self-determined. No external rewards can provide this level of happiness and the feeling of achievement. And they also pointed out that this is deeply associated with our growth.

3 ENGINEERING IS A CHALLENGE TO MAKE OUR DREAMS COME TRUE

Engineering started to make our dreams come true. But the progress of technology led us to the Industrial Revolution and it introduced Division of Labor. We started to work for others. Until then, we worked for ourselves. When we worked for ourselves, making our dreams come true was a challenge to establish "Self". We challenge to actualize ourselves. Challenge is the core and mainspring of all human activities. As Maslow pointed out "Self-Actualization" is our final need and as our way of living varyies from person to person, so our "Self" world varies accordingly.

We should note that such "Self-Actualization" not only satisfies our final need and brings us the maximm happiness and the feeling of achievement, but it also serves from the standpoint of "Evolution". Even if some "Self" may not meet the changes of the Real World outside, other "Self's" survive. Therefore, humans can survive as species.

Design, especially Engineering Design started to make our dreams come true. We perceive the environment and situation and are motivated. Therefore, we make a decision on what action we should take to achieve the goal. If it satisfies our expectations, we feel emotionally satisfied. If not, we repeat the process until our expectations are satisfied. In short, Design is Exploration.
We explore the new frontiers.

We should note that Emotion and Motivation come from the same Latin word "movere". Emotion is e=ex+motion. So, it means to "move out". Thus, we perceive the Real World and are motivated. So we move out into the outer Real World to establish our "Self" world. What Maslow, and Deci & Ryan pointed out is the importance of "Self". Design is our activity to establish our "Self" world (Figure 2).

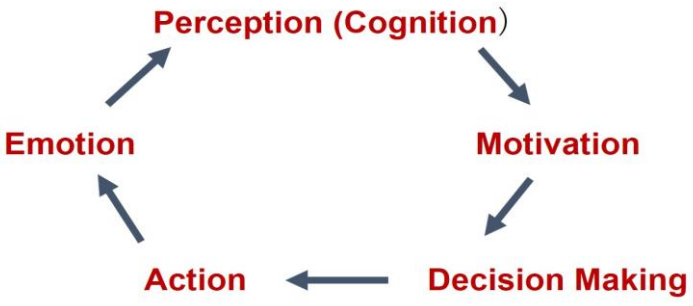

Figure 2. PMDAE

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4 BARTER SYSTEM TO MONEY SYSTEM

In the old times, we worked for ourselves to make our dreams come true. That was “Design” in the old days. But we needed a wide variety of things to achieve this. Thus, we invented money system to reduce the burden of finding things that meet our needs, To establish this system, we need a wide variety of products and parts. Therefore, we needed to evaluate them objectivel y and quantitatively. Money system shifted our society from challenge- and self-driven to technology-driven. Thus, "Technology" emerged as main driver in our society. Design, therefore, shifted to pursuit of technology. And as a result of such tremendous effortS in advancing technology, we brought forth the Industrial Revolution. It does not care too much about “Personal” pursuit of happiness and the feeling of achievement. What came to matter is whether we can provide enough amount of products or parts on an equal basis. Thus, the Industrial Revolution introduced “Division of Labor” and we started to work for others. Design at this time was production design.

5 TECHNOLOGY-DRIVEN SOCIETY

The Industrial Society, therefore, deprived us from actualizing ourselves. Instead of satisfying human needs, our focus shifted more and more toward materials. Thus, more and more, we came to prefer logical and objective approaches and paid efforts to quantitative evaluation. As the current computers are based on 0-1 basis, i.e., based on Euclidean approach, which is interval scale based with units and orthonormality is required among datasets.

But we must remember that the concepts such as units is related with human movement inside our body. We lift up and we understand what weight means. We walk and we understand what length means. So, we opt to think that technology is scientific, but in reality it is not. We understand the idea or concept through our body movements.

6 HUMAN MOVEMENTS

Human movements are divided into two. One is Motion, which can be observed from outside. The other is Motor, which is the movement inside of us, such as muscles, etc.

Nikolai Berstein clarified Motion (Bernstein, 1967). At first, our motion trajectories vary widely from time to time, but as we get close to our target object, our muscles harden and start to work together with our skeleton. Thus, we can easily idenfiy parameters in this musculoskeletal system . So, we can easily control its trajectory. Most of movement work deal with this stage. Therefore, “Control” was the primary focus until very recently. Design meant how we can develop control systems.

Then, why our motion trajectories vary so much at first? It is because we need to adapt to the changing environment and situation. We need to mobilize all parts of our body and coordinate them to balance our body to adapt to the changing outside Real World. Thus, “Coordination” becomes increasingly important (Figure 3).

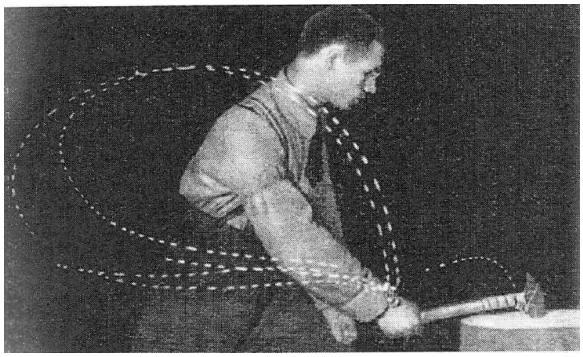

Figure 3. Motion trajectories

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The design of “Control” is static. We move on with the context. We perceive (observe) the environment and situation and we can control. The design of “Coordination”, however, is dynamic. We must predict the future, when the environment and situation vary from time to time. Or it may be better to say “Proactive”.

7 THE REAL WORLD IS CHANGING

As the curse of dimensionality tells us, we cannot solve the problem of large dimesion mathematically. As our world is expanding rapidly and what make the problem even increasingly difficult is yesterday changes were smooth, so, we could differentiate them and predict the future. But today changes become sharp, so we cannot differentiate them and cannot predict the future.

Further, materials are getting softer and softer with the remarkable progress of matetrial engineering. Yesterday, objects were hard. So they were called “Hardware”. We could eunderstand what the object is and how we should handle it with our eyes alone, even from a distance.

But today they change to “Software”. So we need to interact with the object directly. But we mustt estimate how it wiil change.The current design is static. We design based on our knowledge and current observation. But as the changes become frequent, extensive and occur in an unpredictable manner, design from now on needs to predict the future, i.e., how the environment and situation will change next moment. In other words, “Cognitive Intelligence” becomes increasingly important.

8 DESIGN FROM WITHIN: BORN TO DESIGN

Jean Piaget proposed Cognitive Development (Piaget, 1928) and made it clear that babies up to 2 years old learn how to interact with the outside Real World by direct interation. They are born to design their actions. No one teaches them how to crawl, walk, etc. And we must remember “Intelligence” is not knowledge, i.e. the structured accummulation of past experience. In the case of babies, however, they structure knowledge moment after moment and this process itself plays an important role. And we should note “Intelligence” means “to understand”. It means to understand what the environment and situation mean and what action we should take. Yes, it is associated with immediate or reflective decision making. This is “Design”. We design our life and learn our own way how to survive. As our bodies are different from person to person, we need to design, based on our own body sensations and body movements. That is why we are born to “Design”.

9 DIGITAL AND ANALOG

Betty Edwards, American sketch artist, published a best seller “Drawing on the Right Side of the Brain” (Edwards, 1979) and made it clear that children up to seven years old draw sketches as they see. But after seven, they start to draw sketches on “Concept”. We need to process a wide variety of information when we grow up. So, this is very natural. Thus, we come to organize information in a quantitative and objective manner. The current computing is based on 0-1 basis. So DX (Digital Tranformation) is getting wide attention. And “Brain” is getting wide attention, too. But most of the discussion about “Brain” are focusing attention on “Digital Processing”. “Brain”, however, process not only “Digital” information, but it also processes “Analog” information. Thus, very recently, such researches as “Brain-Morphic Computing (BMC)” emerged. BMC pays attention to “Analog” processing.

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Further, AI is getting wide attention today, but the current AI only pursues expanding its search space and completely lacks the function of “Cognition” or “Awareness”. And we should remember AI consumes 10,000 times energy than a human brain. So, AI cannot support our society. It is an excellent tool, but we should “Design” its applications where it works best for the true benefit of our society. We should change our perspective to make the most of our inborn abilities. This is another important “Design”. We should consider how we can develop self-satisfying and self-enjoying society. We are stuck in the mindset of the Industrial Society. The industrial Society is getting close to its celing and we should start to “design” the next society. We must aim to create a completely new society by integrating “Digital” and “Analog”.

10 BRAIN AND HEART

Up to now, we have focused our primary attention to “Brain”. But we should pay attention to “Heart”. We are now shiftting from material-focused Industrial Society to “Emotional Society”.

Wiiliam Wordsworth composed a poem “My heart leaps up when I behold a rainbow in the sky”. Our heart heats up when we get excited. No matter whether data are “Digital” or “Analog”, our “Brain” processing is rational and logical. “Heart”, on the other hand, is more associated with “Emotion”. And “Blood” is “Analog”. Our “Heart” sends out signals throughout our body using “Blood”.

We should also remember that even after the dealth of “Brain”, our “Heart” keeps working and circulating “Blood”. During the time “Blood” is flowing, we can transplant our organs to someone else. Our true death comes when our “Heart” stop circulating “Blood”. “Heart” and “Blood” play a very important role for our design of life.

11 INDIVIDUALS AND GROUPS

The discussions up to now are primary focused on individuals. In the age of “Self”, individuals consititutes the basis of discussion. But as Maslow pointed out, we are connected each to each and we form a society. To design and develop a new “Emotionl Society” after the Industrial Society, we need to pay attention to “Groups”. In other words. We should consider designing and developing a platform where we can share our feelings.

Let us take music for example. Music can be played accurately using musical score. But musical score music will bore us soon. We go to concerts or listen to singers, because they are expressing their feelings. Their musics are not the reproduction of “Signal”. Theirs are “Noise”. Design is nothing other than to create “Noise”. “Emotion” is “Noise”. When we can share “Noise” and feel the same way, we are truly forming “Emotion-shared Socity”. This holds true with paintings. Although the points that impress us vary from person to person, we can share and enjoy the same painting.

12 EMOTION AND DECISION MAKING

As shown in Figure 2, we perceive the environment and the situation and understand the context. This motivates us to take action. So, we need decision making what action we should take. As described earlier, “Emotion” and “Motivation” come from the same Latin word “Movere”. So, “Emotion” means to move out (e-ex=out + motion). We move out into the outer world to establish our own world. This is nothing but “Design”. We “Design” our life.

But decision making calls for prioritization. The Industrial Society was material-focused so it was cardinal number-based. But as decision making plays a crucial role in “Emotion-focused Society”.. We must introduce ordinal number approach. Further, as the curse of dimensionality teaches us, if the dimension of the problem becomes too large, we cannot solve it mathematically.

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But come to think, our daily life is changing frequently, extensively and in an unpredictable manner. Still, we live our daily life without trouble. Why? Yes, that's right. we have “Instinct”. We are born to design with “Instinct”. Yet, we forgot about “Instinct” in the Industrial Society. We pursued “Technology” and “Science”.

What we should puruse is AI (Artificial Intelligence) in the true sense. In the Industrial Society, we have pursued to overcome the Natural World and establish “Human World” against it.
The word “to move out into the outer world” here means not to fight against Nature, but to eastablish our own world within Nature. AI is part of Nature. It is not a tool to fight.

13 SUPPORTING INSTINCT

Everyone is born with “Instinct”. Although “Instinct” varies from person to person, it leads everybofy to make a decision what action he or she should take and spend daily life without trouble. As Jean Piaget pointed out. babies directly interact with the Real World and learn on their own how to crawl, walk, etc to survive. So, what is needed is a tool to support our “Instinct”. We should help it make a decision.

14 MAHALANOBIS DISTANCE-PATTERN (MDP) APPROACH

Decision making is required continuously in our dail life because our daily life situations vary from moment to moment. As Piaget pointed out, we learn how make a decision by interacting directly with the Real World when we are babies. We learn by ourselves how to train our “Instinct” to make better decision. But as we grow up, our world becomes increasingly complex and complicated. Therefore, we introduce “Concept” to reduce the number of dimensions, as Betty Edward pointed out.

In relation to reduction of dimensionality, let us take up Quality Cotnrol. Genichi Taguchi is famous for his Taguchi Methods (Taguchi, 1954). This approach controls product quality element by element. But for most industries, it is substantially impossible to control product qualty element by element. So, they manage to secure qualty as a whole on factory or organization basis. Taguchi realized that his aproach does not meet the real needs of industries, s0 he developed Mahalanobis-Taguchi System (Taguchi, Chowdhury, and Wu, 2000). This is a combination of Mahalanobis Distance (MD) (Mahalanobis, 1936) and Pattern. Quality Contorl Taguchi Method is Euclidean approach. It is cardinal scale based. But MD is ordinal and is interval-scale-based. Decision making is a strategy. So, what matters is prioritization. Which decision should be taken first. MD was developed to remove outliers. It is just how far the pont P is from the mean of an individual dataset. Thus, we can remove outliers with the longest MD first and then remove the second longest and keep on removing. Thus, MD can be used for prioritizing strategy.

Shuichi Fukuda and his group used to study to detect emotion from face. But image processing techniques took too much time and without satsifactory results. Fukuda realized when we see a cartoon, we can detect emotions of characters at once and without any difficulty. So, they introduced cartoon face model and succeeded to detect emotion at once and without any dfficulty. They deomstrated the effectiveness of pattern approach (Kostov, et al. 2001).

Taguchi combined MD and pattern. MTS is, however, a static pattern matching. But our world is dynamic.So, MDP introduced Recurrent Neural Network (RNN). But RNN assigns weights to links in a random mannter. We cannot manage it. So, in MDP, “Reservoir Computing (RC)” is introduced. RC enables us to make adjustment at the output. We can manage the system as we wish (Figure 4).

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RC has another great advantage. It enable us to introduce micro technologies. We can make sensors and actuators extremely small. So, we can make them part of our body and we can use sensor and actuator at the same time. We can sense and actuate at the same time in real time. In traditional sensing and actuation, we detect signals by sensors and then we apply actuators that can handle them. It is sequential processing and there is a large time delay. RC, on the other hand, enables simulatanous and real time processing and as sensors and actuators can be part of our body, it contributes extensively to enhance human capabilities. RC is a great driver of "Human Enhancement" or "Human Augmentation".

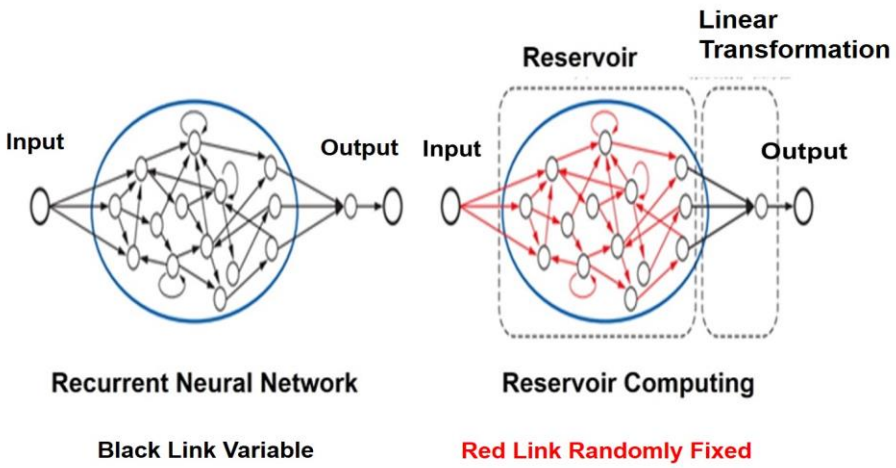

Figure 4. Reservoir computing

MDP is an intinct support tool combing MD and pattern. This approach is unique. Up to now, no attention has been paid to "Iinstinct" in traditional engineering. "Design" and "Instinct" are discussed separately.

MDP can be understood easily if we take swimming as an example. Water changes from moment to moment. Therefore, we cannot identify parameters and we cannot apply mathematical approaches. But if we put wearable sensors on the swimmer, we can produce such a data sheet shown on the right. Each row corresponds to the muscle at each location. We calcualte MD between T_1 and T_2. If MD is decreasing, we know we are using the muscle in an appropriate way, but if MD is increasing, we need to change its movement. Note we just provide "Instinct" with the situational information and "iInstinct" coordinates these pieces of information and balance the body so that we can swim in our own way. As our body varies from person to person, our swimming style varies individually. What we need to design our swimming style is the holistic view. That is what MDP provides.

Figure 5. Mahalanobis Distance-Pattern (MDP) approach

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