

Understanding System Dynamics with Eastern Philosophy

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Abstract

In this paper, I discuss how to teach system dynamics and systems thinking from the perspective of the eastern philosophy, especially in Korea and China. Based on my experience of teaching system dynamics to Korean people for 15 years, I present some kind of fundamental similarities and linking pins between eastern philosophy and system dynamics. Presentation of their similarity usually provided Korean students a kind of familiar feeling with the system dynamics and facilitated their understanding of its key concepts. Also I explain my experience on presenting research outcomes of system dynamics to Koreans with the help of linking pins between system dynamics and eastern philosophy.

Keywords: Eastern philosophy, systems thinking, yang, yin

I. My experience on teaching System Dynamics and Taijitu

From 1995 to present, I taught system dynamics to students in Universities and gave lectures to business men in social education program. At first, I taught them that system dynamics is developed in MIT and have a deep intellectual root of western philosophy (Richardson 1991). I found that most Korean students regarded the perspective of system dynamics as strange to their thinking style. Especially, when teaching computer modeling of system dynamics, students often thought that the thinking style of system dynamics is too strange to learn. That is why I started to emphasize the linking pin between system dynamics and eastern philosophies. If there is a similarity between them, students would not think system dynamics as strange and hard to learn.

Although I felt strong and fundamental similarities between system dynamics and eastern philosophy, I could not find any discussion on their similarity. Some exceptional researches on the relationship between feedback though and Buddhism shows only superficial similarity between them. I needed a more fundamental linkage between them that can give my students familiar feeling toward system dynamics.

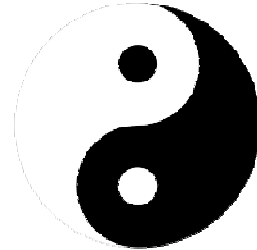
Even though my students regarded system dynamics as a strange perspective, I had a strong feeling of similarity between system dynamics and eastern philosophy. I started to question myself and reflect on where comes my strong feeling of their similarity. It took not a long time to realize that my feeling of their similarity comes from the taiji. Wikipedia introduces taiji as follows.

Taiji 太極 (literally "great ridgepole") is a [Chinese cosmological](#) term for the "Supreme Ultimate" state of undifferentiated absolute and infinite potentiality, contrasted with the [Wuji](#) 無極 "Without Ultimate". (from Wikipedia)

Taiji(太極) is the most fundamental concept of eastern philosophy. Taiji is not only a basic philosophical concept but also a basic way of life in eastern countries. Although eastern philosophy and civilization is filled with the concept of taiji, no one knows exactly from when the concept of taiji began. All Korean, Chinese, and Japanese know the concept of taiji well. Even one can say that eastern people live with the concept of taiji.

On my reflection, I realized that my strong feeling of similarity between system dynamics and eastern philosophy comes from the similarity of the essence of system dynamics and taiji, especially the symbol of taiji. The symbol of taiji is used for representing the concept of taiji and usually called taijitu. In this sense, the taijitu can be regarded as the essence of eastern philosophy. Again Wikipedia explains the taijitu as follows.

Taijitu (太極圖; “diagram of ultimate power”) is a term which refers to a Chinese symbol for the concept of [yin and yang](#) ([Taiji](#)). The taijitu consists of a symmetrical pattern inside a circle. One common pattern has an S-shaped line that divides the circle into two equal parts of different colors. The pattern may have one or more big dots. The classic Taoist taijitu (pictured here), for example, is black and white with a black dot upon the white background, and a white dot upon the black background. (from Wikipedia)



All Eastern people are well accustomed to the taijitu. The national flag of Korea comes from the taijitu. While I had a need for finding similarities between eastern philosophy and system dynamics, the taijitu came to me as a bridge between them. In taijitu, I saw a concept of feedback thought, negative and positive polarities, and cycle changing behavior pattern.

From that moment of realization, I taught my students that the perspective of system dynamics is similar to that of eastern philosophy. When I and Doa-Hoon Kim and Tae-Hoon Moon published the first textbook of system dynamics in Korea in 1999, the book cover was designed to reflect the similarity between taijitu and system dynamics (Kim, Moon, Kim 1999). And when I wrote another book on systems thinking in 2004, the similarity between taijitu and systems thinking was introduced and used as guiding framework to understand the essence of systems thinking (Kim 2004). Until now, when I give a lecture on system dynamics and systems thinking, it is a rule for me to explain the similarity between taijitu and systems thinking for the first ten part of lecturing time.



Figure 1. Book cover of the first textbook of system dynamics in Korea

II. Similarity between taijitu and system dynamics

Taijitu is a symbol representing many eastern philosophies, including Taoist and I-Ching. In my lectures, I focus on the similarity of ‘I-ching’ and system dynamics. I-ching(易經), often translated as “book of change”, is one of the most fundamental textbook for Confucianism, idea of which ruled eastern countries for last one thousand years. In Korea, I-ching is also known as Chu-I (周易). Chu-I means a theory of dynamics (易) that is developed in Chu dynasty of China. From this point, my lecture begins. I-Ching and system dynamics has a same intellectual goal; dynamics. They are developed to answer the question, why system changes. In this sense, they represent studies for dynamics, contrary to statics. While most of textbooks of Confucianism are statics teaching social order, I-Ching is an exceptional study for dynamics. The one is ancient dynamics, and the other is modern dynamics.

I give question to students. System dynamics and I-Ching have same question to answer. Do they give different answers to the same question? Of course, their answers are different. But I emphasize that the perspective in their answer is basically same. To explain their similarity, I use the taijitu. My next question to students is how many elements are there in taijitu. After hearing answers from students, I give my answer, 3 elements of taijitu as figure 2.

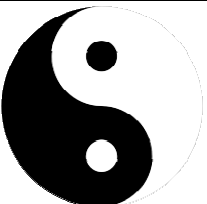
Taijitu	Element of taijitu	Element of system dynamics
	S curve in the middle	Everything is changing. Behavior over time graph.
	Yin in the left Yang in the right	Negative polarity of loop that oppresses change. Positive polarity of loop that reinforces change.
	Circle in the border	Feedback loop.

Figure 2. Similarity between taijitu and system dynamics

The first element is S curve in the middle of taijitu. The middle S curve represents changing area of two power, black and white. Their areas are changing constantly and symmetrically. If we rotate the s curve in taijitu by 90 degree, we can see fluctuating behavior pattern in time. The s curve in taijitu represents a basic perspective of “everything is changing”. This comes naturally from the fact that both I-Ching and system dynamics is focusing their attention on changing dynamics rather than constant order.

The second element is a black and white area, yin and yang. In the eastern culture, yin and yang is a kind of force. Yin is a force that oppresses change, while yang is a force that reinforces change. Usually, yin is linked to woman that is quiet, and yang is to man that seeks changing. In the lecture, I explain that yang and yin is matching to the negative and positive polarity of system dynamics. System dynamics has two kinds of polarity, polarity of causality and polarity of feedback loops. Because it needs long time to explain them, I explain only the role of polarity in system dynamics. The role of the polarity in system dynamics is to distinguish the forces that oppress change from the other forces that accelerate change. Furthermore, in Korean language, ‘negative’ is translated as ‘yin’, while ‘positive’ is translated as ‘yang’. So, ‘negative feedback’ is translated as ‘yin feedback’, while ‘positive feedback’ as ‘yang feedback’. So, it is natural to Korean people that yin and yang is matching polarities in system dynamics as forces oppressing/reinforcing changes.

The third element is a circle in the out border of taijitu. I raise a question to my students why the outer contour of taijitu is a circle rather than rectangle or triangle. And I remind them that the circle in the eastern culture means feedback loops. In taijitu, the circle means that yin and yang forces are connected each other as a feedback loop that can produce changes constantly. At this stage, I stress to my students that the circle in taijitu and feedback loops in system dynamics is most important elements to understand dynamics, because only they can produce changes forever.

Often I ask to my students how our ancestors could make such an observation and symbols. And I give my answer. My answer comes from the heaven-land-human thought. Heaven-land-human (天-地-人) thought is the most basic philosophical perspective for Korean. From the ancient times, Koreans thoughts that the world is composed of heaven(天), land(地), and human(人).

To explain my answer to students, I draw a picture that a man sit down in his house and see the moon in the heaven and see his garden in the land. And I say that he might see the constantly changing shape of the moon. He collects all shapes of the moon from the crescent moon to the full moon. Connecting all shapes of the moon into one icon, he finds out S curve in the middle of the taijitu. While he see his garden in the land, he find yang land(陽地) where sun shines and yin land (陰地) where are covered by shadows. He found that yang land is full of changes with new flowers and birds, while change in the yin land is oppressed. And thus, he thought that the change can be understood by yang and yin. Lastly, he sees himself in the middle of heaven and land. And he gets realization that he is the feedback channel between heaven and land. Explaining the picture of heaven-land-human, I teach my students that the fundamental perspective of system dynamics and taijitu is closely linked to that of ancient Korean.

Lecturing these similarities between taijitu and system dynamics, I could find that many students do not regard system dynamics as a strange thinking. Rather I emphasize that system dynamics and systems thinking are in fact an oriental way of thinking developed in western civilization.

III. Understanding system archetypes with yin/yang (man/woman)

If there are similarities between the basic perspective of taijitu and system dynamics, there might be another similarities when applying them to systems. Especially, I point out their similarities when I give lecture on system archetypes (Senge 1990). In eastern culture, yin is referred to woman, and yang is matched to man. In the lecture, I reinterpret system archetype as yin and yang, that is, as woman and man (Kim 2009).

1. A negative feedback loop with time delay = fluctuation

A negative feedback loop with time delay is an archetype for producing fluctuating behavior (Sherwood 2002). From the perspective of yin and yang, this structure is reinterpreted as time delayed yin force. Yin is a force to keep balance and equilibrium. If yin has a time delay, her balancing efforts get out of the target and she is getting nervous. As a joke in the lecture, I give an example of fluctuating mood of a woman who is near to dead line of work or marriage.

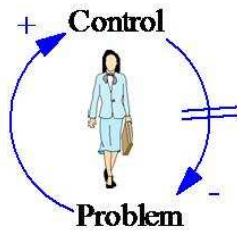


Figure 3. Fluctuating yin as a negative feedback loop with time delay

2. A pair of negative feedback loops = Equilibrium

An example of a pair of negative feedback loops that produce equilibrium behavior is a market pricing mechanism. This archetype is interpreted as two women (yin) cooperating to keep the system order. Sometimes, in my interpretation, a woman in the supply side is involved in the long-run equilibrium, and a woman in the demand side is involved in the short-run equilibrium.

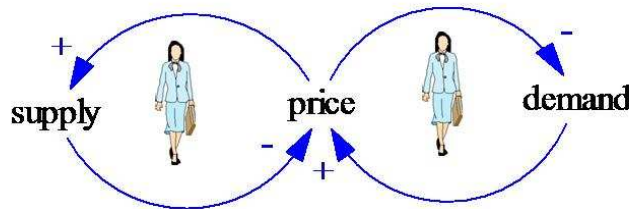


Figure 4. A pair of woman as producing equilibrium

3. Marriage of positive loop and negative loop = S curve growth

This archetype is one of the most popular growth systems. It is also known as the archetype of limits to growth. The essence of this archetype is that in the first time the positive feedback loop dominates the system and produce growing behavior. And in later stage of the time the negative feedback loop gets the dominating power over the positive loop and the system goes into the equilibrium. In my lecture, this archetype is explained as a house where husband (yang) work to increase their income and wife (yin) keep their expenditure in balance. Usually, in Korea, yang has a dominance power in their first half of the marriage, and yin get the dominating power in the later stage.

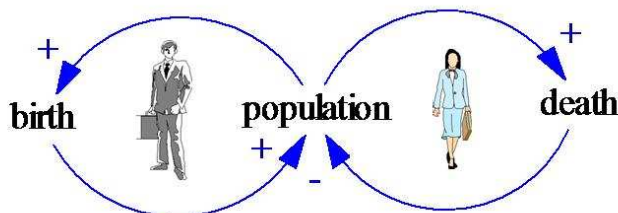


Figure 5. Shift in the dominance between yang and yin to produce s curve growth

4. Two yangs competition = the rich get richer, the poor get poorer

The archetype of the rich get richer can be interpreted as a competition system which is composed of

two yangs (positive feedback loops) competing each other. This competing system will result in destroying the poor. In the lecture, this archetype is explained as a fighting between two men until one's death.

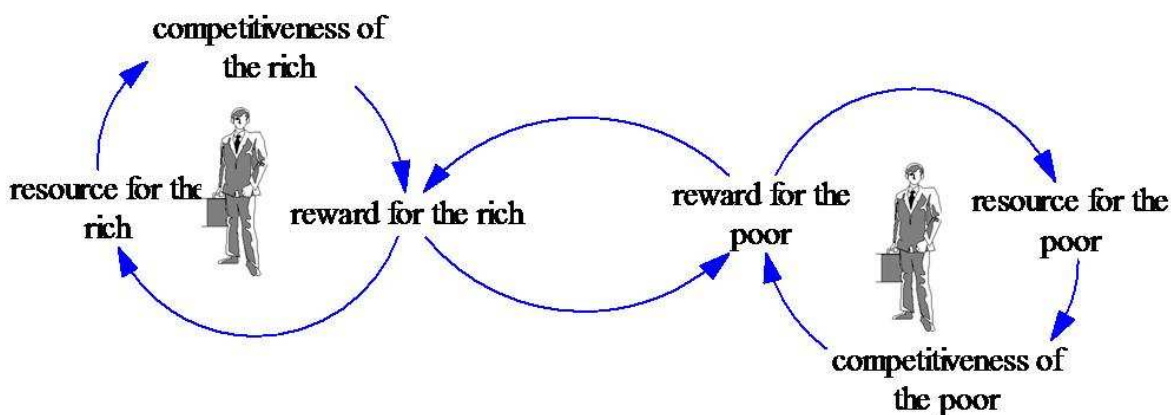


Figure 6. The rich get richer archetype as competition between two yangs

5. Two yins competition = escalation effect

The archetype of arms race show different competition behavior. Although arms race archetype shows escalation of competition, it does not result in the rich man get richer. While the rich get richer competition system is composed of two yangs (positive feedback loops), arms race competition archetype is composed of two yins (negative feedback loops) as in figure 7. In the rich get richer archetype, two yangs (positive feedback loops) try to maximize their resource infinitely. In the arms race archetype, two yins (negative feedback loops) try to keep the level of competing power each other.

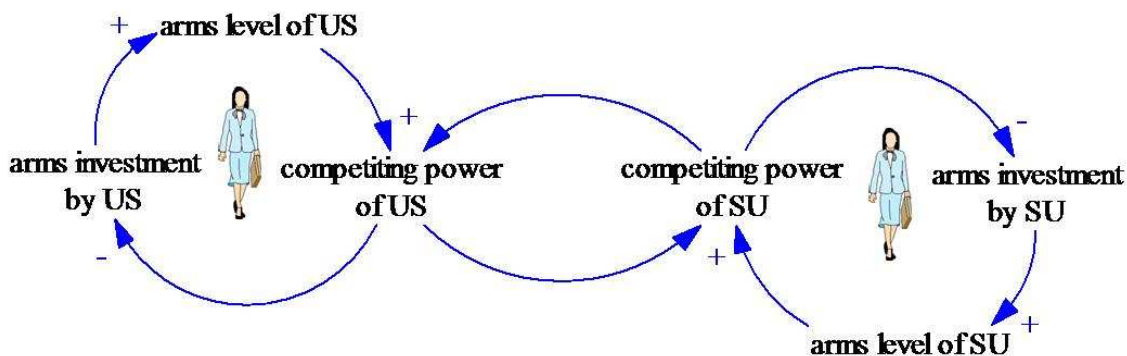


Figure 7. Arms race as competition between two yins

Comparing these two competition archetype, I often give joke that competition between yangs (men) is more disruptive than that of yins (women), because the poor cannot continue the competition in the long run. In the same reason, I usually points out that the latter tends to produce long competition than the former.

In my lecture I note that my analogy between system archetypes and yin/yang is only a matter of philosophical perspective. That is, one should not apply my analogy to man and woman in real world. In the real world, man can perform the role of yin and vice versa. Also I add that the negative feedback loop that is linked to yin is not negative in the value system. At the same time, the positive feedback loop and yang has not positive value. Their value is neutral. In my lecture, I note that they

should be interpreted only as a force for oppressing or reinforcing change in the system. The change may be good or bad according to the situation.

From the experience of teaching analogy between system archetype and yin/yang, I found that students can grasp the meaning of the positive/negative feedback loops more quickly. With the analogy, students can link their cultural experience in eastern society with the systems thinking. This may facilitate their learning and practicing of systems thinking.

Another important lesson from the analogy is that some students can start to use feedback loops as a building block in their thinking. As I teach analogy yin/yang to feedback loops, some students begin to say that “positive feedback loop is a growing engine” or “negative feedback loop is a balancing device”. As eastern people is accustomed to think yin/yang as a building block, analogy between yin/yang and feedback loops can help students to think feedback loops as a thinking block. Although this effect is hard to measure, I believe, this will be the important research issue in teaching systems thinking (Wolstenholme 2003).

IV. Presentation of SD model with eastern philosophy

If eastern philosophy is effective in teaching system dynamics to eastern people, it will be also helpful in presenting system dynamic models to their clients. When I developed system dynamics model on Korean information networks in 1997, I had an experience that eastern philosophy can be helpful in the presentation (Kim 2003). Usually clients do not understand system dynamics model. Although my causal loop diagram was simple, it was too complicated for government officials to be understood. However, when I explained SD model in terms of eastern philosophy, they began to understand the essential dynamics. Figure 8 shows two versions of presentations for introducing dynamic mechanism embedded in the network expansion (Kim & Juhn 1996).

As the number of subscribers in the network grows, the value of the network grows by the effect of network externality. The network externality can be interpreted as a single positive feedback loop of figure 8. However, as the number of subscribers grows, congestion and crowding effect in the network diminishes its performance and decreases its value for consumers. The crowding effect in the network can be represented as a single negative feedback loop of figure 8.

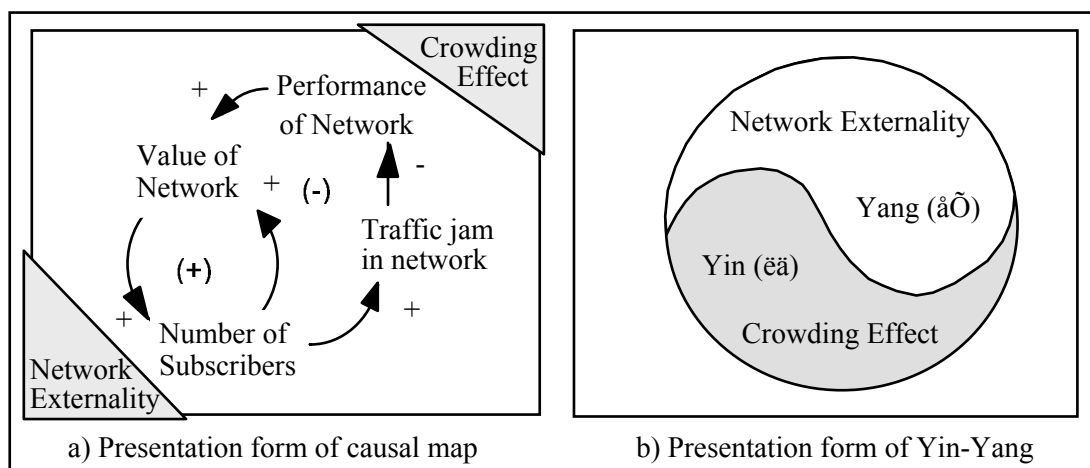


Figure 8. Two versions of presentation forms

I converted the causal map of our model into Yin/Yang diagram in figure 8. Yin/Yang diagram may look too simple to convey any dynamic mechanisms. However, Yin/Yang diagram has profound meanings to the eastern people for more than two thousand years. They could get deep insights on the interactions of network externality and crowding effect. Furthermore they could understand the limits to growth phenomena surrounding the evolution of networks. From this experience, I realized that

cultural elements must be incorporated into the presentation form of system dynamics models.

V. Future challenge: understanding eastern philosophy with system dynamics

In this paper I tried to summarize my teaching experience in understanding system dynamics with eastern philosophy, especially taijitu and yin/yang. The most important lesson is that they have lots of similarities. They see the world as a constant changing system, try to find change-oppressing forces and change-accelerating forces, and believe in the essential role of feedback loops in producing constant change.

If one can understand system dynamics easier with eastern philosophy, one might say that one can understand eastern philosophy more profoundly with the help of system dynamics. The most striking example is the concept of five basic elements (五行) of the universe in the eastern philosophy (Kim 2003). Five basic elements are represented by tree(木), fire(火), earth(土), gold(金), water(水). In Korea, seven days in a week are made of five elements with Sunday (sun, 日) and Monday (moon, 月). The concept of five elements is used in oriental medicine, cooking foods, and even predicting the future.

The most interesting fact is that eastern people recognized feedback loops among the five elements.

There are two kinds of relationships: promoting (相生) and counteracting (相剋). The promoting relations can be regarded as the positive influence in system dynamics, and the counteracting relations as the negative influence. Figure 9 shows the famous map of promoting/counteracting relationships among five elements in eastern philosophy.

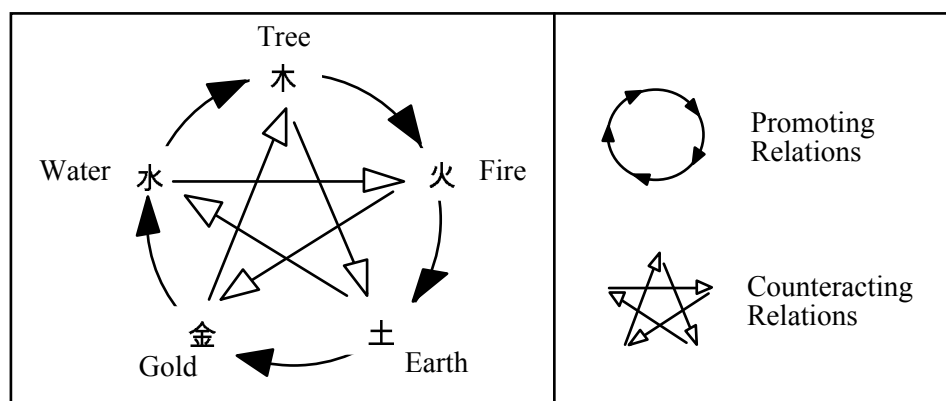


Figure 9. Feedback Structure of Promoting/Counteracting among Five Elements (五行)

These relationships can be understood with the everyday life examples. For example of promoting relationships, you can make a fire with tree, the fire converts various kinds of materials into trash and earth, the earth produces gold and ores, gold and ores transform moisture into water, and water fosters the tree. On the contrary the counteracting relations go like this. The water extinguishes the fire, the tree destroys the earth with its roots, the fire melts the gold, the earth oppresses the flow of water, and the ax made of gold cuts down the tree. It has served as a basic analytical framework in medicines, philosophies, and governments for two thousand years (Seo 1995).

As a system dynamicist, it is easy to find that the promoting circle is a positive feedback loop and the counteracting circle is a negative feedback loop. With this analysis, one can say that the promoting circle is reinforcing but unstable, while the counteracting circle is stable and provides equilibrium to

the system. This analysis may give insight to eastern philosophy that the counteracting relationship might be helpful to system as a whole. Usually eastern philosophy says benefits of promoting relations, while ignores the role of counteracting relations. With the help of system dynamics and systems thinking, eastern philosophy may develop richer insight into using the counteracting relations.

I hope that my teaching experience can be a seed for integrating the wisdom of eastern philosophy and systems thinking. This intellectual fusion represents bridging ancient wisdom to modern civilization, and connecting western intellectual power to eastern insight. In the future, a new dynamics can be emerged by integrating Chu dynamics and system dynamics.

Refereces

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