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## Starting "Leadership R&D" Activities
## — Field Origination in the Complex System View —

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Abstract

For the science of leadership to be practical in the true sense, it must be able to explain the relative merits of a leader's actions, and also be able to design methods on how best to foster leaders as human beings, and how leaders can motivate the group or organization. It is when the outcomes of leadership research activities (R) can be applied to leadership development activities (D) that the science of leadership indeed becomes practical. Moreover, the essence of the leadership structure is the individual to the group/organization, and their interrelationship forms a complex system. Leadership R&D activities must maintain this view.

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# 1.    Introduction

"Leadership R&D" is a combination of two distinct terms — leadership is a business-related word that has its basis in the study of humanities, while R&D is a technical term centered in technologies and engineering. It was coined by the authors in search of a phrase that could express the fusion of humanities and technologies/engineering.

Under this title, this paper will highlight the importance of truly practical leadership science, and point out the processes leading to its origination. It is when the outcomes of leadership research activities (R) can be applied to leadership development activities (D) that the science of leadership indeed becomes practical. The aim of this paper is to undertake R&D on leadership, and put forward this concept.

# 2.    Global view of leadership R&D

## Leadership science based on the fusion of humanities and technologies/engineering

The need for the leadership R&D term stems from the following observations the authors have made over the many years spent on leadership-related research. While we can pursue science aimed at gaining a detailed understanding of leadership, it tends not to pass on the steps for effectively executing that leadership. Regardless of how much scholars refine their knowledge of leadership and communicate this to business leaders, they find it difficult to link this knowledge to concrete methods of action to motivate their groups or organizations. There is a difference between theoretical knowledge and the ability to execute. Science that provides a detailed understanding alone cannot fill in this gap.

For the science of leadership to be practical in the true sense, simply explaining why a leader acts in certain ways is not enough. What is also critical is that leaders must be able to design methods that can best motivate the group/organization. To this end, it is necessary not just to grasp leadership as a humanities science relating to humans, but also to apply technologies and engineering that conducts R&D to obtain methods of leadership execution. This is why a term that brings together humanities and technologies/engineering was essential.

A precedent for a new science with terminology combining humanities and technologies/engineering is "financial engineering." Finance is a humanities term based in economics, and incorporated with this is the technological term engineering.

Financial engineering is a practical branch of learning aimed at the efficient use of capital, and an interdisciplinary science that extends across many academic fields including economics, accounting, insurance, finance, law, statistics, probability, mathematics, and computer science (Nishina, Kotani, Nagai, 2003). It was developed in the United States in the mid 1970s, and has given rise to many concepts and techniques actually used in management such as portfolio theory and real options. It was developed as a practical science, i.e., for the efficient use of capital, in response to the question of "how".

Unlike disciplines in which specialist fields are researched and broken down in detail, financial engineering utilizes the research outcomes from many of these specialist fields to achieve practical and social objectives. It goes beyond the search of knowledge as to "why something is the way it is". Practical leadership science in the true sense should be like this.

## Looking back on conventional leadership research

Before moving on to discussions with the purpose, we will look back on conventional leadership research from the perspective of research methods and philosophy.

Leadership research to date has placed greatest emphasis on questionnaire surveys and their statistical analysis. To this, Yukl (2002) pointed out the limitations of these surveys. In short, these questionnaire surveys were limited structurally in that they requested from respondents their recollections and interpretation of events or actions that occurred.

Many questionnaires ask leaders or those concerned whether and how often specific events or actions occurred during a given period. But there is no guarantee that they will always be conscious of and accurately remember the specific event or action, and often the response has to rely on an uncertain recollection. Moreover, ambiguity in the questions may also give rise to differences in interpretation among those taking part. A respondent's feelings toward a certain leader (e.g. like or dislike) may also color the respondent's answers to the questions.

Statistical analysis also has its own limitations. Pinpointing a causal relationship is difficult with this method. Virtually all cases of statistical analysis work out a correlation coefficient, but with

this there is no way to tell which is the cause and which is the effect. Regardless of how many variables are incorporated into the survey, the presence of a hidden variable is always a risk, possibly creating the appearance of a causal relationship that in effect may not exist.

Why have we persisted in conducting leadership research using only these methods with all their inherent limitations? There are a number of reasons. One of the main reasons is the constraint caused by the framework of how the researcher wants to understand reality. The understanding is in line with the framework, so the framework constrains the choice of research methods. This is implicit. This framework of understanding is a paradigm of modern scientific philosophy of a mechanical global view. Researchers have received their training to become researchers within this framework, so they have been implicitly restricting themselves.

The mechanical global view is also synonymous with the term reductionism. This is the concept of separating the subject into detailed elements, studying each element in depth, then assembling the obtained knowledge to gain an even better understanding of the subject. This is the same as the idea that machines are formed from component parts. If the parts are assembled, they will form a machine. This concept is why it is called mechanistic theory. This view is a paradigm developed based on the laws of the physical world to accurately predict changes there.

How, then, does research into leadership fit into this global view? For example, the following theory that has been researched quite extensively — the two-factor theory of whether a leader is task-oriented or relations-oriented — gives an ample indication of such a mechanical global view. This research breaks down leadership into two factors, then based on a detailed and integrated study of these factors, establishes the concept of leadership. One person may have a high rating for task orientation and a low rating for relations orientation (high-low), while another person may be rated the opposite — low task and high relations orientation (low-high). Yet another person may have a high rating for both (high-high). In this way, the leadership of each individual is analyzed in an effort to help predict leaders' work performance.

To actual leaders, though, this theory tends not to be particularly useful. This is because leaders deal with groups of people, not machines. Even though a leader may be judged through a questionnaire to fall under a specific type of leadership, e.g. "low-high", it would be inconceivable that the leader would always under all circumstances be that type of leader. With a different group/organization to lead, non-type actions will invariably appear according to the group/organization. This is a limitation of the of type classification leadership research through combining factors, and tends not to act as an

engine for motivating and bringing about change in an organization formed from a broad range of people. Applying the mechanical global view to material research allows a high capacity for prediction, but the opposite is the case when it is applied to human society.

## Sub-optimization leading to total optimization

These days, the authors often relate the following in classes at the Business School. Any major work is always divided and shared. The work is divided into parts along some form of axis, and individuals are responsible for each of those parts. The axis of work division may be function, product, or region. The problem is that even though individual parts may be achieved, this does not mean that the original major work is achieved. Even though all parts may be then brought together, it tends not to readily form the total.

This not only tells of the form of work division and integration in the organization, but also the essential issue of leadership. What kind of relationship should exist between leadership toward individual members of the organization and leadership toward the organization as a whole? Even if individuals perform their responsible tasks satisfactorily, this only realizes sub-optimization; total optimization for the organization cannot be achieved. This must be considered to be an issue of leadership.

The question of part and whole can be said to be a major problem lying dormant in today's business organizations. This situation is fiercely demands experts or professionals. Specialist graduate schools expected to educate these people were already established in response to such a leaning toward professionals, and have been increasing and expanding over the past few years. However, fostering these professionals does not necessarily foster leaders who can aim at total optimization. Even if experts alone carry out the work, this does not automatically generate total optimization. As an aside, although those traditionally referred to as generalists who are highly competent at coordination and are suitable to serve in managerial positions, it goes without saying that they are not the leaders sought in this paper.

We will also touch on the following even though it may digress slightly. It is often said that doctors these days may be able to cure diseases, but they are not able to cure patients. This, of course, relates to Western medicine. In traditional Chinese medicine, though, it is said that when treating patients, doctors will treat the "person" without looking only at the "disease".

High-level specialization in medical care has given rise to narrowly segmented and specialized medical technology, and has contributed to curing difficult diseases. On the other hand, though, lifestyle-related diseases and dementia are quite common these days. They are complex diseases closely connected with society and lifestyle, and the adverse effects of medical care tend to manifest through segmentalization and specialization. For this reason, even though, say, treatment may only be partial, as long as it is provided in part with an eye to the whole, and not in part because of functional segmentalization, a method of treatment that leads to the recovery of the health of the patient should be able to be devised. Traditional medicine is one form of medical care that has its roots in such an idea.

The macrobiotics dietary method based on the concept of an inherent association between diet and health is similar to this. This dietary method is founded on the base that the nutrients necessary to sustain oneself are determined by the climate and geological conditions of the region in which one resides, the activity level, and physiological conditions. It aims at regaining intrinsic natural balance between the overall human mind and body through the preparation and consumption of food such as brown rice, vegetables, seaweed, beans and traditional seasoning in a form appropriate to the particular food.

Humans have no direct control of the individual body parts, but they can act on not just the functional condition of individual internal organs but the body as a whole by understanding their environment and the food they eat on a daily basis with the various constraints of heredity and culture.

In short, this is one method in which manipulating part will lead to the manipulation of the whole. Such a process must also be possible in leadership as well. Formation of sub-optimization naturally must be linked to the realization of total optimization.

## The organization cannot be steered from the cockpit

Although not entirely correct, let us liken the inflected form of the leadership science the authors are seeking to establish to a cockpit. The pilot of a large jet aircraft operates many levers in the cockpit. The operation of these levers gives the aircraft's huge body the necessary movement to take off from the runway, maintain stable flight in changes of weather, and land.

Here we likened a leader operating an organization to a pilot in the cockpit, but of course this is not correct. In the case of the aircraft, operating the levers is acting on mechanical parts, and the body is nothing more than an assembling of parts.

An organization is a collective whole that is a society of people. If the leader carries out some form of action on those people, they will comprehend and act as autonomous human beings. They are not mechanical parts, so even though they may be operated by the pilot's lever, they act having incorporated their own thoughts and ideas to it.

Nonetheless, the leader wants to operate the organization from the cockpit. That feeling is easy to understand, but the leadership science aimed at in this paper is not about sitting in the cockpit of a jet aircraft as the organization is not a collection of mechanical parts. It must be a science that enables the traditional medicine or macrobiotic cockpit operation of a group of subjective people.

Moreover, that is "second-person" science. The essential characteristic of a leadership situation is the relationship between oneself and others; i.e. between the "individual" and the "group/organization". Both are human beings, and the realization and actions undertaken by the leader within the interrelationship of oneself and others is leadership.

Pursuing "third-person" science will not give rise to a practical meaning. The significance of research by scientists into the condition of the "individual" to the "group/organization" through the third person is an increase in the knowledge on the part of scientists — the "third-person". Objective, i.e. third-person, leadership understanding will be formed as a scientific outcome. In most cases, though, it is of no use in designing usable methods for leaders who are working in the second person.

"Second-person" science is useful for determining what the leader (oneself) needs to do to motivate the organization (others). This science is not "cognizing science" aimed at deepening the understanding of things, but "designing science" aimed at building up methods (Science Council of Japan, 2003).

**Pursuing leadership science in the second person**

What kind of humanities and technologies/engineering studies should be gathered together to conduct leadership science in the second person? The following are the authors' thoughts. We can gather and incorporate studies researching the essence of human autonomy, the essence of the relationship between humans, i.e. between autonomous beings, and the essence of collections of humans, i.e. collections of autonomous beings.

Though, it is not simple. The accumulation of studies on human beings is indeed vast. To assemble the essential items from among this requires some form of framework. Naturally, the basis of

the framework is that "humans are autonomous beings". That is, think for oneself, act on the basis of that thinking, or change that thinking as necessary. Another fundamental is that "humans interact" — interact subjectively as autonomous beings.

This framework presents a different perspective from the previously mentioned mechanical global view or reductionism. Looking at the history of the development of science, applying this framework forces a shift in thinking regarding cause and effect, that is, the principle of causality.

The pilot sitting in the cockpit only experiences a linear causality principle in that operating the lever will alter the movement of the aircraft. The order of cause and effect only flows from operating the lever to moving the aircraft. On the other hand, when a leader — a human — applies a certain operation to the organization — a group of humans — the group comprehends and acts as an autonomous body. The leader took the action in anticipation of this to a degree, but an unforeseen reaction occurred in the organization, so the leader devised a further leadership action. But the organization …. A continuation of this act is the principle of causality in which the cause and effect recurs.

Pursuing the science of leadership in the second person begins from a recognition of the interaction among humans. It is not an interaction among machines. Rather, it is an interaction among human beings with subjectivity and emotions; interaction among humans as autonomous entities. There is a need to shift from the paradigm of the linear causality principle to the paradigm of the cyclical causality principle.

## Cyclical causality principle and complex systems

Essentially, the actions of the leader and those of the members form a relationship in which both sets of actions can act as cause and effect on each other. Very rarely is the cause and effect relationship unidirectional in communities comprising multiple humans. In most cases, we can readily see the phenomenon of a cyclical causal relationship with the actions of the leader and members. In short, before the leader acts, the leader anticipates the subsequent action of the others, and seeks to factor that into the initial action.

While studying causal relationship from the perspective of the cyclical causality principle regarding leadership and other social phenomena is extremely critical, it is only fairly recently that this research has actually been carried out. This is due in part to the following issues with research

techniques. Until recently, there had not been an adequate method of obtaining a solution to nonlinear differential equation essential for analyzing the cyclical causality principle, nor had sufficient progress been made in the computer technology needed for this (Simon, 1996). Finally, a series of studies using complex systems terminology was actively initiated in the perspective of the cyclical causality principle from the latter half of the 20th century.

Here we will briefly touch on complex systems. Similar to terms such as reductionism and mechanical global view, the term complex systems provides one way of looking at the world. So in itself, it does not point to a specific theory or principle.

A system is a collection of a number of interacting elements. Researchers came across systems in which there is no simple linear relationship (i.e. unidirectional relationship from cause to effect) among the elements, and were interested in the fact that the movement of the system is extremely complex. The system with a bidirectional effect among elements and showing complex behavior overall was termed a complex system.

In fact, interest in this research has been around for a surprisingly long time. It is said that it originated from Newton's discovery of universal gravity pointed out in *Principia* (original, 1687). At the end of the 1800s the mathematician Henri Poincare tackled the three-body problem of what kind of movements are shown if three point masses pull on each other through universal gravity. While research into this problem continues today, Poincare showed that the orbit of the differential equation becomes extremely complex if it attempts to solve this problem. This phenomenon is called chaos, and it came to indicate a system in which a slight change in the initial value will at once alter the orbit. Although deterministic, this system is characterized by the fact that a complete prediction is impossible because a slight initial change can vary the outcome significantly.

With the progress of computer technology from the latter half of the 20th century and its effective use as a research tool, researchers in various fields have detected chaotic behavior behind many phenomena. Research results by meteorologist Edward Lorenz published in 1964 are still widely cited today. He explained that the weather is a phenomenon caused by chaotic changes in air currents, and the mere flapping of the wings of a single butterfly on the Equator has the potential to cause a typhoon. The slight initial change to the atmosphere by the flapping of the butterfly's wings can develop into a major typhoon.

The increase of such research results has created a research field known as complex system science. The global view is not reductionism, but that the character of the whole is not uniformly

determined by the combination of the elements. The reason it is not uniformly determined is that it recognizes "emergence" that cannot be argued through the mechanical linear causality principle. Langton (1989), a proponent of artificial life, explains emergence as follows. Many elements acting autonomously generate macro-order through micro-interaction. The order thus generated, though, constrains the behavior of the elements. New functions, character, and actions are formed in the system through the bidirectional dynamic process from micro to macro and vice versa. This is "emergence". In such a system, the causality principle is always cyclical.

Research into complex systems these days is extensive and advancing rapidly. It would not be wrong to say that this expansion arises from the limitations on research methods that take a mechanical view of the subject of the research and seek to reduce it to its elements. Kaneko (2001), who is researching biophysics from a complex systems viewpoint, states the following.

> *I have certain misgivings with molecular biology. Molecular biology seeks the cause molecule by tracing back through the chain of cause and effect regarding a certain life phenomenon. Then, searching for the gene that manifests in response to this, it views life as a combination of such "logical expressions". ... (omitted) ... Why do I feel such misgivings about this standpoint? First, many biologists come across unexpected behavior shown by a life system even under controlled conditions. They are realizing various unstable factors causing a deviation from mechanical behavior. The role of the molecule (gene) is often diverse, and a one-on-one cause and effect cannot be found, or the role itself changes according to the situation. ... (omitted) ... It would appear that the life system is stable based on a good relationship between the whole and the elements (p.v.).*

The authors share similar misgivings about conventional leadership research. Though we endeavor to describe the relationship between cause and effect through "logical expressions" by cutting off sections of the area in which the leader operates, there are just too many reality situations that do not fit. Moreover, missing from within the "logical expressions" in the linear causality principle is emergence, i.e. the dynamism generated from the interaction among humans. How does the leader view, consider, and act in relation to the group/organization. At the same time, the group/organization also views, considers and acts in relation to the leader. For this reason, leadership science must be set up in the second person, and this requires a paradigm shift to the cyclical causality principle.

## Use of the agent-based approach

A paradigm shift to the cyclical causality principle was accelerated by the scientific theory "agent-based approach" put forward in the latter half of the 1990s (Axelrod, 1997; Axelrod and Cohen, 1999). Agents are autonomous entities. Scientists who take up this theory press the importance of looking into the autonomous entities and their interaction when applying science to group/organization and social actions. The first author is also a member of this group of scientists (Takagi et al., 1995).

The agent-based approach seeks to determine what kind of actions an agent will take in response to the actions of another agent, and what kind of actions this will lead the interacting agents to take as a whole. That is, the agents recognize their position within their environment, consider the action formula, carry out their actions, then after obtaining a feedback from their environment, alter their recognition and undertake new actions. Agents do not exist in a void; rather they share the environment with many other agents. The agents' environmental recognition is a recognition of their relationship with other agents, and the agents' actions are an interaction with other agents. This itself is the cyclical causality principle. Agents can be humans or animals, or robots that move by self-correcting software so they can perform as described above.

## 3. What needs to be done in the leadership "R"

The essence of the leadership structure is the individual to the group/organization. The new science of leadership pursued by this paper must be able to give the leader an understanding about the individual and the group/organization, and facilitate the design of methods to lead them. At the same time, it must also be tied in with trust in the leader and the leader's growth and development as a human being. Because of this, leadership "R" (research activities) and "D" (development activities) must be closely linked in respect to "human beings".

Although the term "leadership engineering" can be similarly coined, it does not, however, fit the authors' intention if it points only to the technical pursuit of leadership. Engineering aims at technical refinement in the manipulation of the target object. Financial engineering, which was raised earlier in this paper, has funds as the target object, and aims at technical refinement in how

those funds are invested. If we apply this to leadership, it leans toward refining the skill to motivate the target object, namely people, and will enable the formation of highly accurate mind manipulation techniques.

However, leadership purely as a method is in itself not something we should do as humans. The case of people engineering with people as the target object contains much more meaning than when people engineer an inanimate object as the target. If "leadership engineering" is conducted based on the outcomes of leadership "R" activities and from this the techniques for motivating the group/organization could be formed, the leader who employs those techniques must gain trust and grow and develop as a human being. This is what is aimed at in leadership "D" activities.

## Human autonomy is contained in the "brain"

This paper so far has laid all the necessary foundations. Utilizing these, we will examine theories that are useful in leadership "R" activities. What is necessary first of all is a theory for understanding the essence of human autonomy. Next we will look at understanding regarding the group/organization. These theories should indicate the process for establishing new leadership science.

We have already talked about macrobiotics and cockpits, so readers should by now be used to our at times somewhat erratic commentary. So next we will talk about brains. To understand human autonomy, we must first understand the brain. Human autonomy manifests as an action of the brain.

The brain is a collection of nerve cells. But even if we take out a single nerve cell, it cannot tell us about the function of the brain. Although analyzing a single nerve cell will show the protein structure of the cell, it does not reveal to us how the nerve cell works. This is because nerve cells are functioning through the constant exchange of information with countless other nerve cells. We can understand what the nerves are doing in a certain region of the brain by looking at it as an information processing network based on the interaction among nerve cells. What is taking place in that region is more than the workings of a single nerve cell. Note that this explanation covers the "relationship between parts and the whole" mentioned earlier.

The brain is also an interaction of many functional regions. It can be classified into the cerebrum and cerebellum, and we also know that the brain has an association area and a language area.

The hippocampus is responsible for memory, and the cerebellum is responsible for whole body sensory information. The key point is that when we look at the overall brain, we can see that each functional region acts closely in concert with other functional regions; it is not a segmented linkage in which a specific part performs only a specific function. There is no clear segmentation of functions, rather the whole is formed through a loose interaction and sharing of roles. This is also a relationship between parts and the whole.

## Renew existing models through learning

Considering leadership, the brain activity of a leader has important characteristics. This is represented by the word "model". When a leader exercises leadership over a group/organization, the leader is conscious about "what kind of situation is to be formed by taking what action and how in which direction through what methods". What the leader is conscious of is maintained as a kind of image structure inside the leader's head (i.e. inside the leader's brain). This structure is called a model (Takagi, 1995). The leader may have a clear model beforehand, or the model may become progressively clearer in the process of working with the group/organization.

In both cases, what is critical is that the leader must have the group/organization embrace the same model that the leader has. The leader must ensure all members have that model, and share it as an overall group/organization. Of course, there will also be times when, as an existing model is shared, a new model evolves and is taken up by the leader. In any event, there is no questioning that this is one of the crucial actions of leadership. This is also in a part and whole relationship.

What does it mean to have a model as a function of the brain? This is understood as the following from research into "learning". A model is a framework that recognizes the external world, or oneself; i.e., it is a structure. It is a standard when understanding information obtained both internally and externally, and is like a filter letting us know what to choose and what to eliminate. People make decisions and act on the basis of this model. So learning is renewing this model in response to experience and circumstances, and as a result, actions change (Brookfield, 1986). As already mentioned, the authors are scientists who use the agent-based approach, and the theory regarding human learning and model renewal is indeed in line with this approach.

The fact that in management leaders constantly have new models for developing business means that the leaders themselves are undergoing the process of learning. And the fact that the

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group/organization, the target object for the exercise of leadership, comes to embrace new models also means that the group/organization is undergoing new learning formation. The group/organization is a collection of individuals, so this means that each of those individuals is also learning anew.

If the leader were able to exercise leadership by sitting in the cockpit of the organization and operating a lever, there would be no learning by the group/organization. This is because the object of the operation is a machine. The reality of displaying leadership by an autonomous individual to an autonomous group/organization is a simultaneous learning process for both sides.

Here we will touch on the formation of collaboration critical in the display of leadership from the relationship of the individual to the group/organization. The leader generates a new model from interaction among the group/organization members. This is collaboration, i.e., cooperative creative activities. To put it in a different way, it is learning by way of model renewal by many individuals. Members with an existing model who have interacted mutually renew the model as a result of some form of inspiration, successfully creating a new model. The leader, who is positioned within this cycle, also takes part in the learning process. This action in which the leader, who is merely a part, and the members, who are also merely a part, achieve mutually creative learning to generate a new model as a whole is collaboration. This is also a phenomenon known as self-organization in the sense that the group/organization gives rise to new order from within their creative interaction.

## Chaos fluctuation and attractor shift

To take this further, what does it mean that the human brain has a model? Research into the chaos of complex systems is useful for understanding how the brain maintains and renews models (Tsuda, 1990; Kaneko & Tsuda, 1996; Kaneko, 2003). The brain is a complex system of vast cooperation among nerve cells. Brain waves are one manifestation of brain activity, and it is as well-known fact that chaos fluctuation can be observed when these brain waves are measured. The brain does not continue operating with firm stability, rather it is constantly fluctuating irregularly.

The part and whole relationship can also be observed clearly in the brain activity fluctuations, i.e. the chaos fluctuation. This is a cruel experiment, but chaos fluctuation can be observed when an electrode is inserted into the brain of a living monkey and the changes to the potential of a single

nerve cell are measured. It can also be observed when changes to the potential are measured in a single functional region, and in the overall brain as a whole.

The fact that chaos fluctuation can be observed at the cell level, the functional region level, and the overall brain level resembles the mechanism by which the ocean causes erosion of the land. The erosion mechanism on the rocks at a small beach is similar to the erosion mechanism on the entire coast of that region. Seen from a high altitude, it closely resembles the shape of a ria coast. A similar shape of the part and whole is called a fractal structure, and it can also be seen in the chaos fluctuation of the brain.

What do we mean here when we say that the brain maintains and renews models? Plotting the change in potential shown in brain cells and functional regions on a time-series graph produces an infinite curved orbit with several strange converging vortexes (attractors) (Fig. 1). Observing this over time reveals that after remaining in a specific converging vortex for a certain period, the potential change shifts to another vortex. And, perhaps triggered by something, it can either return to the original vortex or jump over to a completely new vortex.

Figure 1: Example of attractors

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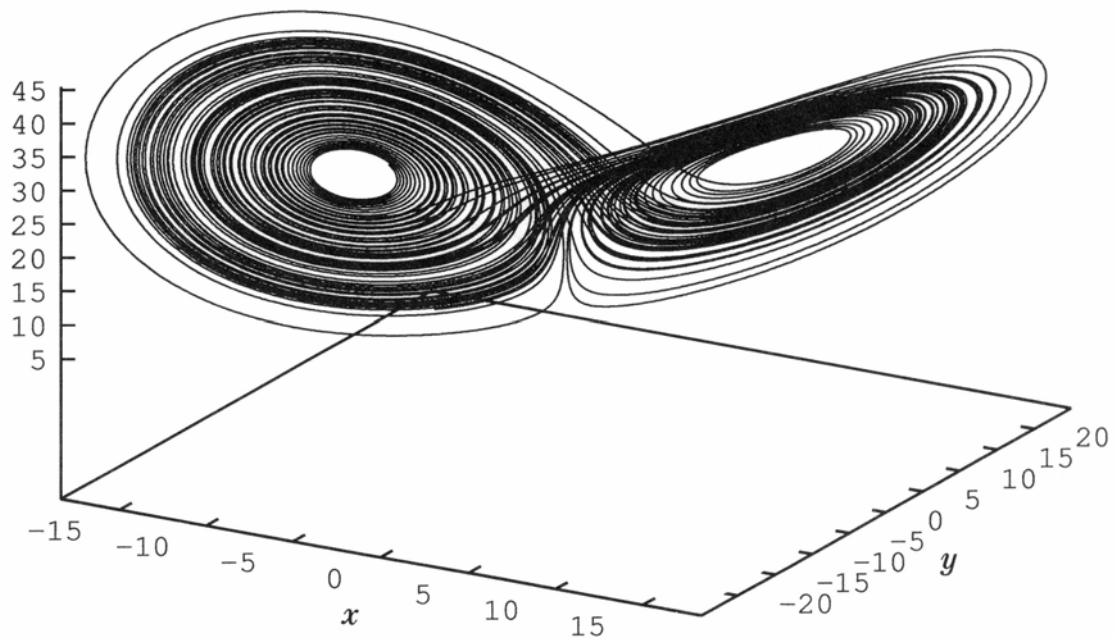
Next is simply conjecture on the authors' part, and we really should wait for further progress in brain research, but the following can be considered. The brain's maintaining a single model is a condition where brain activity converges for a set period in a certain attractor. Renewal of the model through learning perhaps represents a change taking place in the brain activity attractor due to some kind of conditional change.

The display of leadership by a leader toward the group/organization is perhaps the act of requiring a shift or transformation of the brain activity convergence position (attractor) of each individual. Or it can also represent the formation of new attractors as a group/organization. Again, this is conjecture by the authors.

Moreover, in leadership, the leader mobilizes all aspects of communication technology. The only way a leader can press the group/organization to shift internal attractors is to communicate with the group/organization in various forms. Here the leader should be able to utilize the fact that the attractors of the overall group are in a fractal relationship with the attractors of individual members. Working on the attractors of the parts makes it possible to work on the attractors of the whole. The opposite is also possible. This, of course, is also conjecture by the authors, and much more research into this is necessary.

The leader wants to and has to raise the motivation of the group/organization. The same can be considered on this point as well. Motivation of the group/organization is heightened when the mission is shared among the members including the leader, and activity begins to move in the same direction. This is a fact that many know from experience, and is also confirmed through research (Takada, 2003). A similar conjecture to that above can also be made here — it is thought that a resonance of awareness and high motivation arises when the models held by individuals converge into attractors of the overall group/organization to form a sense of common ownership. A leader who seeks to motivate the group/organization must generate a resonance of awareness among members through a shared model.

## 4.   What needs to be done in the leadership "D"

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## Focusing on adult learning

When an individual acts as a leader, it means that the individual understands human nature, and has grown and developed as an adult to the extent of being able to lead the activities of the group/organization. Having an understanding as an adult is to understand "what humans are, what they are thinking at what times, and how others respond to how oneself is".

To design leadership "D", that is, activities to foster and develop leaders, a group of theories relating to methods for raising the adultness of individuals engaged in business activities is essential. Raising adultness means that the adult is learning and growing. In this light, the framework of the agent-based approach used in "R" can be used here.

As will be mentioned later, the authors have been conducting case method classes in a discussion format. From this, it has become apparent that adult learning requires the following three conditions to be met (Takeuchi, 2004): 1. The autonomy of the individual in question is guaranteed; 2. Specific matters are dealt with under specific conditions; 3. Mutual discussion, mutual cooperation and mutual learning among multiple individuals.

These three conditions are in line with the agent-based framework. Lecturers and course students are individuals who discuss from an autonomous position of independence, and form a collection of agents. They pursue learning by stating their opinions and judgements with each other and renewing their own awareness, i.e. models. In short, the relationship activity of individual entities promotes the learning of the individual entities.

It may be the case for young people's learning, but for adult learning, there is no effect in literally stating abstract concepts. Furthermore, learning goes hand in hand with some form of self-denial. Adults move a step closer to self-denial only after their autonomy is guaranteed. For this reason as well, there is a need to deal with tangible matters. Even when dealing with abstract matters, adults do not connect those abstract matters to themselves. Moreover, they do not act in isolation, rather they act after consulting with and prompting a number of people.

Some readers may noticed this while reading, but the reason OJT is so effective under a superior who understands is that the three conditions mentioned above are satisfied. In reality, though, this is often little more than having people work under the banner of OJT. Even where superiors comprehend the importance of OJT, there may be times when they will struggle to satisfy those three conditions.

Additionally, the well-established practice of personnel rotation has been significance in fostering employees when the wishes of the individuals concerned and the expectations of the superiors are aligned. Over the past few years a growing number of companies have reportedly been unable to carry out effective staff rotation because of a lack of organizational leeway. A continuation of the organizational situation where the three conditions cannot be satisfied causes a stagnation in human resources development.

## Rehearsal in the brain

In company organizations, business activities themselves often provide an opportunity for both training and development at the same time. It is also a fact that personnel transfers are carried out with this expectation. Considering the effectiveness of OJT, though, how to best utilize training and seminars is crucial.

However, of the three conditions for effective adult training mentioned above, the second is the most difficult to satisfy in classroom leadership training. The classroom is not a place of business, so even though the class may be handling actual business material, it is nothing more than mere simulation.

Even though this is only simulation, at times the information activities within the brain can have such a sense of realism that the training will progress with a strong feeling of reality. This feeling of real substantiality is due to the actions of the brain function known as qualia (Mogi, 1997).

Naturally, real activity generates a sense of reality within the brain. This is normal. In the case of qualia, a real sense of experience can be developed in the brain through the use of sophisticated functions relating to the brain's memory and recollection even though there is no actual experience. Moving images of activity in the head can generate a sense of reality such as an actual experience within the brain.

Applying this theory can process simulation within the brain while gaining a sense of reality on a par with actual experience. This is a vital brain activity referred to as "rehearsal" in the brain (Bandura, 1985). In very simple terms, this is a sense of information in which only muscle activity is missing from the actual experience, and at the same time, it is virtual activity with a sense of reality. The effect from rehearsal in the brain is gained as though it were actual experience, and has great significance in learning by the individual.

Athletes visualize within their brains the technique of their actions before the event, and the movements their bodies will make to deliver victory. This is what is referred to as image training, and is a rehearsal within the brain in which qualia is used.

## Usefulness of the case method in leadership development

There is no question that experiencing business activity in itself provides an effective opportunity for leadership development. So, we should look for potential that can supplement this or provide an even greater opportunity in leadership training and seminars. Various teaching methods are used in training and seminars. From among these, which methods are "D" for that stated at leadership "R". Here we can focus especially on the "case method" from the viewpoint of adult learning and rehearsal in the brain mentioned above.

Of course lessons can also take the form of a kind of workshop. The point is that the rehearsal function in the brain can be applied while satisfying the conditions necessary for adult learning. As will be mentioned later, the case method is one of the methods that can satisfy these conditions.

The case method is a lesson format in which the class discusses business facts contained in case teaching material. Lecturers do not lecture on their own knowledge to the class. Rather, they lead and guide the discussion so that all members of the class can state their respective views and judgements on an equal footing. Through this, the class collaborates to reach a decision on the problems presented in the business example (Barnes et al., 1994). The case method clearly satisfies the three conditions necessary for adult learning mentioned earlier.

How does the case method proceed in classes run by the first author? The following is his sketch of what took place on one of particular day.

> *The discussions carried out in small groups before the class discussion have*
> *finished. The students then moved from their group rooms to the class. Some*
> *students were walking along the corridor looking as though they needed more*
> *time to finish their discussions. In the class, some took their seats while still*
> *dragging out the discussion from the group room, while others were deep in*
> *thought as they read the case material one more time without being able to fully*

*grasp the point at issue. The class comprises students with a diverse range of job experiences and backgrounds.*

*"Well then, let's start the discussion." The lecturer who guides the discussion continually sends out verbal and nonverbal messages that he is also taking part in the learning process. "Civility", "willing to take risks" and "appreciation of diversty" are essential for the class discussion. These three words that underpin the group learning of the case method form the spirit embodied by the lecturer and shared by the students. It is only when this condition is maintained in the class that the students gain the trust and confidence of each other, and they gain a new sense of self.*

*The lecturer running the class throws out questions to initiate discussion, and while taking notes on the blackboard of the opinions raised, he seeks further opinions. At times he sorts out the connection between opinions, and summarizes the views expressed. He will stand at the head of the ebb and flow of the discussion, then move around to follow as the discussion heads along its own course. At times he is very animated, and at other times he is more serene. He is like an orchestra conductor creating the flow and atmosphere of the work.*

*The students are straightforward in expressing their opinions. Rather than being hesitant, they are speaking out as if they don't realize it. "There is no incorrect view" and "constructive counterarguments that respect the opinions of others". The ones who feel the most impact of their own opinions and the greatest sense of satisfaction or incompleteness after making their statement are the students themselves.*

*In the second half of class discussion, the students are pressed to make ultimate critical decisions as the people involved in the management issue. In terms of real experience, this is like being tested under fire. Here there is always a moment of deathly silence. Some students are waiting for the opportunity to speak out, and having overcome any anxiety they may have felt, they express their own decisions with courage.*

*At the end of class discussions, a broad sense of conclusion may form with comments such as "I see," or "Yes, that's how it needs to be done". Or they*

*may leave the room at the end of the day with a strong feeling of discomfort or*
*conflict.*

*There is no one conclusion. And what they learn during class is not the same —*
*each student will go away with something different. The students will then utilize*
*what they have learned from navigating the twists and turns of class discussions.*
*They change their realization into learning based on trust. And what they gain*
*from the accumulation of this is their growth as human beings — the very*
*objective of the case method.*

## Agent-based approach bridges "R" and "D"

Students who work on the case method are adults working in business management with life experience of 20, 30 or 40 years. They deal with management issues in business on a daily basis. They feel much more familiar with dealing with actual business examples, i.e. case study material, than with any other theoretical material or texts containing abstract concepts.

They explore latent management problems as they discuss the case among themselves. Their brains are actively considering how they as leaders can structuralize or model the problem so they are able to reach a decision. Moreover, the students work closely together, constantly discussing their ideas with each other to encourage and stimulate their thought processes.

Being able to describe the progress of learning in the case method class in this way means that the case method can be understood within the agent-based framework. An organization in which many agents (autonomous entities) collaborate has the characteristic of a complex system. This describes the case method class. Lecturers and all students organize themselves while maintaining the necessary course to generate fresh solutions or innovations as leaders. This is a creative process in which the members themselves circulate, rewrite and revise their own models and the model of the class as a whole, and also represents a relationship between parts and the whole. Class discussion can constantly fluctuate, halt, jump, and create, or it can fail and go nowhere. The complex system of the class newly forms and shifts attractors.

Participating in a case method class represents becoming one of the members of the process, and agreeing to self-denial and self-growth. And with this, rehearsal within the brain that goes with

qualia. While the classroom does impose some constraints, it still provides a valuable opportunity for adult growth and development. It also fosters their growth and development as leaders.

As pointed out in leadership "R", the human brain has the characteristics of a complex system from the cooperation and interaction among nerve cells and functional regions. A similar thing occurs in the case method class where students are cooperating and interacting as autonomous entities. This is the essence of why case method learning is effective for developing and fostering leadership capabilities sought within the structure of the "individual" to the "group/organization".

## 5.     Conclusion

Aiming at a fusion of humanities and technologies/engineering in leadership is certainly not impossible using the agent-based approach. In this paper we pointed to this possibility, and sought to develop the processes leading to the origination of the new science.

Here we would again like to touch on leadership engineering. Enhancing and refining the skill to motivate people should be possible by engineering leadership. In particular, the outcomes of "R" activities regarding the chaos and attractors of individuals and the group/organization is invaluable in engineering leadership, and will lead to the development of accurate mind manipulation techniques. For this reason, leaders who employ these techniques must have the trust of others and display growth as a human being. This is what is sought in the "D" activities of leadership. How can and how should leadership techniques be used in the organization? Discussing this issue in the case method class can facilitate the development of human trust and growth that a leader must have.

Finally, we will touch on one more point. This paper has not dealt with the weight that can be given to the inherent qualities of an individual, i.e. genetic conditions, in improving leadership capabilities. Human capabilities are based on human qualities and experience, and in this paper, we have dealt only with experience by way of learning. As an aside, research into identical twins has shown that 30–40% of human behavioral characteristics are determined at the genetic level (Ando, 2000). In the near future, research into this area will have to be incorporated into the origination of leadership R&D science, while maintaining our ethical values.

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