**eKNOW 2014**
**The Sixth International Conference on Information, Process, and Knowledge Management**
**March 23 - 27, 2014 - Barcelona, Spain**

# A Study on Innovation Diffusion Understanding with Multi-Agent Simulation

27th March 2014

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# Self-introduction

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**Wakayama is the capital city of Wakayama Prefecture in the Kansai region of Japan.**

wakayama univ.

国立大学法人 和歌山大学

# One minuets Summary

Final Goal

- We have developed a multi-agent simulation to understand Chasm* in the diffusion of innovation.
- We have gotten suggestions for companies to gain the outcomes of innovation.

Research Value

- Based on the innovation diffusion theory, we defined parameters and made a simulator for Chasm observation.
- From the results of the simulation, we succeeded in generating Chasm.

*Chasm is a big slot in the diffusion of innovation. Chasm was proposed by Moor.

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# Agenda

Background

Purpose

Previous research

MAS design

MAS setting

Experiment

Summary

**This photo is Koyasan temple. Koyasan temple is located in Wakayama.**

# Background(1)
# Background of this paper is as follows.

- The Japanese domestic industry is forced to severe market competition by losing their global competitiveness.
- For example, there are household electrical appliances and high tech products, such as cell phone and television, which the Japanese companies was good at manufacturing in past time.

- Therefore, in Japan, producing an innovation that will be prosperous for the high-tech industry is advocated.

# Background(2)
# I will explain the rest of the background.

- The creation of new markets is difficult for large companies.
- Also, in these domains, there is a view that a venture business is suitable depending on the industry type.
- However, a venture business does not develop easily in our country(Japan).
- The reason why venture company’s leading research does not develop is because of the duration it takes to disseminate the technology.
- This is because the stagnates and a gap (called Chasm) appears.

# Background(3)

- Since this stagnation exists and a gap develops, destructive innovation is assumed and the entire industry of one country is damaged.
- Therefore, in order to be successful in venture businesses, a time reduction method for diffusion of innovation is required.
- Suggestions should be given to companies, including venture companies, regarding stagnation and the gap in the diffusion of innovation.

# Purpose
# The purpose of this paper is as follows.

- We considered that Moore [2] proposed a five-adopter classification for the spread of an innovation.
- This spread depends on how to take homogeneous behavior and differentiation behavior into behavior called strategic behavior.
- Therefore, after giving a definition to an agent as to how to use strategic behavior differently with all five-adopter classifications, MAS should be developed with regard to diffusion of innovations.
- The purpose of this paper was to obtain implications about the conditions for generating Chasm from the experiment of MAS.

# Approach

- We used the Multi-Agent Simulation (MAS) approach in this paper.

- Enterprise adoption of innovation is the act in the real world. So the experiment by changing various conditions is impossible.

- By creating a virtual industry using the simulator, an indication of the experiment results are required for the development of the theory.

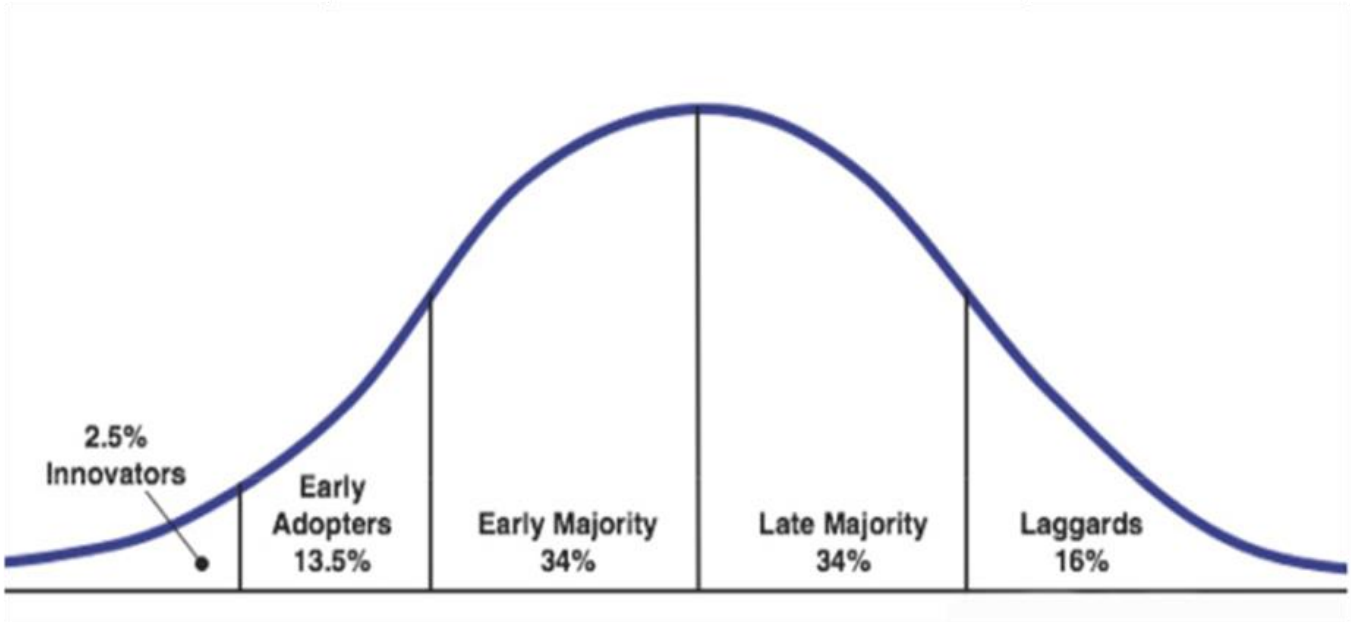
# The previous research on diffusion of innovation

- Rogers [11] classified the customer into five adoptive types in the innovation diffusion model as follows.
  - Innovator,
  - Early adopter
  - Early majority
  - Late majority
  - Laggard
- In this theory, it is supposed that innovation spreads rapidly from the Innovator to the Early adopter (more than 16% of diffusion rate).
- Then, it is assumed that the key to new product spread is what is advertised to an innovator and an Early adopter.

# Model of innovation diffusion by Rogers (1962)

- Figure 1 below is a model of innovation diffusion by Rogers (1962).

Fig. 1. Rogers (1962) Technology Life Cycle



# The previous research on Chasm

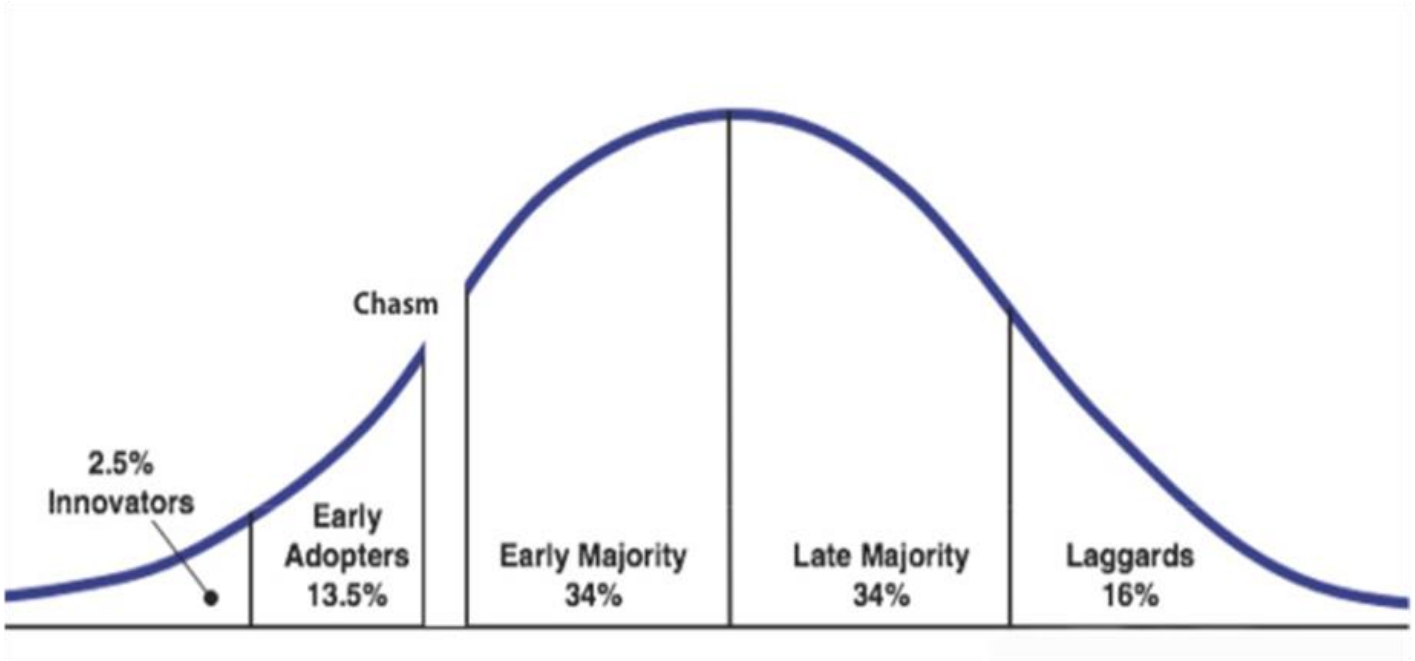
- In the high-tech product that forces a user's behavioral pattern change, Moore [2] discovered a crack among the five-adopter classifications.

- He named this Chasm, and it supposes that there is a deep gap between the Early adopter and the Early majority.

- The gap in Fig. 2 indicates the image of Chasm.

# The previous research on Chasm

Fig. 2. Moor(1991) Chasm



# The previous research on Chasm

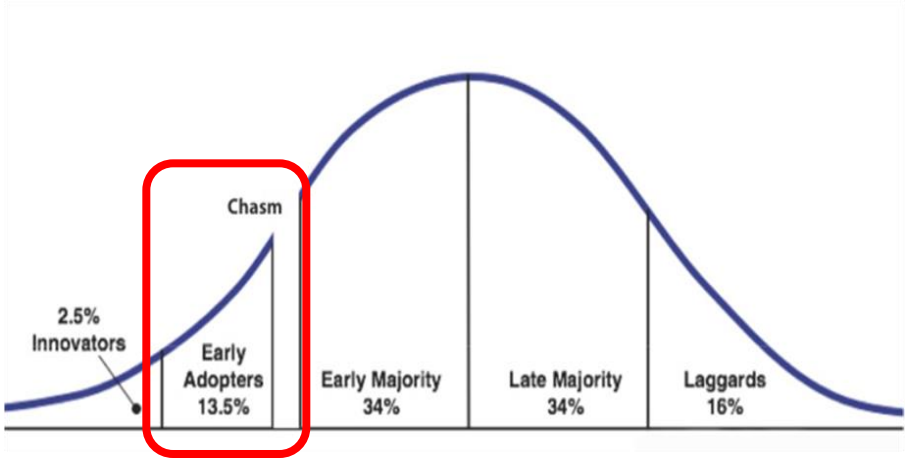
- In order to exceed Chasm, the basic strategy that Moore [2] asserts is responding to the utilitarianism of the Early majority who is a customer segment of the beginning of the mainstream market.
- However, he suggests that the innovation vendor must not provide all early majorities with a product.
- The concrete method exceeding Chasm is concentrating the best in one area. It is important to complete the perfect product quickly toward a certain specific customer segment.

# The five-adopter classifications

- Moore [2] observed the following rates within the five-adopter classifications:
  - Innovator: (2.5%) People and companies that adopt technology aiming for differentiation from novelty.
  - Early adopter: (13.5%) People and companies that adopt technology in the first stage aiming at differentiation not from technology but from an actual profit position.
  - Early majority: (34%) People and companies that check a preceding person's success example and adopt by imitation.
  - Late majority: (34%) Prudent people and companies that copy large majority uses.
  - Laggard: (16%) People and companies that hate new things technically and practically.

# Characteristics of the strategic behavior of Early adopters

- An Early adopter tends to adopt new technology as a "means of change". They aim at the action of a differentiation strategy by staying ahead of their competitor and adopting new technology.
- They introduce new technology with the determination to overlook the risk, in order to obtain a competitive advantage by differentiation. They also often make excessive demands on previously trusted vendor.



# Characteristics of the strategic behavior of Early majority

- The Early majority (utilitarian) positions the product as a "means of an operational efficiency improvement."
- They also copy the example of the usage of the new technology of the other companies in the same industry.
- They want to take action with a strategy of homogeneous behavior.
- However, Early majority specifies the product and technology that were introduced as a company standard in many cases, so technology vendors can expect a high profit ratio.
- Therefore, Early majority is an important customer for vendors.

# Explanation of the strategic behavior

- The differences among these five-adopter classes are what is derived from the strategic behavior principle in a management strategy theory called differentiation behavior (behavior by the snob effect), and homogeneous behavior (behavior by the bandwagon effect).

- This paper examines the conditions of generating Chasm based on two strategic behaviors such as differentiation behavior and homogeneous behavior as agents activities.

# Explanation of the strategic behavior

- Homogeneous behavior (by the bandwagon effect) is that of action to mimic the behavior of others.
  - The bandwagon effect definition is as follows: More people support certain products and services, and the effect of satisfaction and sense of security that the customer obtained by the products and services will increase.
- Differentiation behavior (by the snob effect) is that of action not to mimic the behavior of others.
  - The snob effect definition is as follows: People do not want the same product others bought, and want something different from the product others bought.

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# Configurations of Chasm in MAS

- We used Artisoc3.0 as Multi-Agent simulator (KOZOKEIKAKU Engineering Institute).
- We focused on the consumer market as the simulation market for a group of companies in a certain industry targeted for the diffusion of innovations.
- The case where an innovation spread through industry is assumed in this paper.

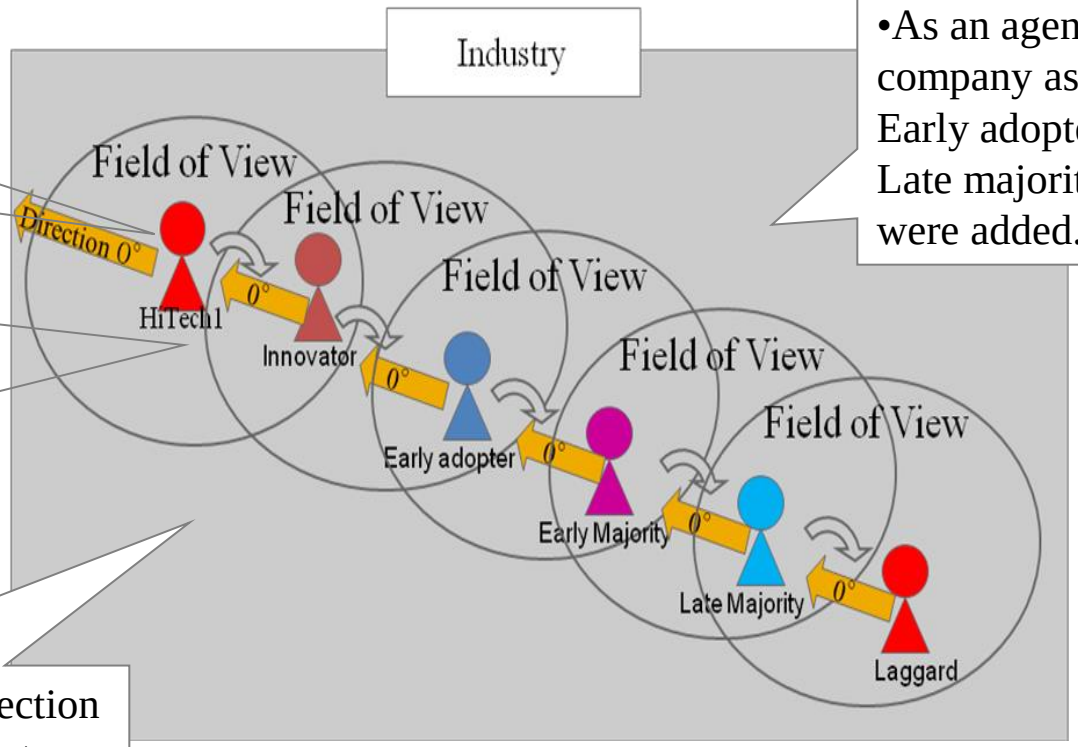
# Fig. 3. Innovation Diffusion Model

•Space Industry was added to the Simulator.

•Agent High Tech1, which expresses as an innovation of the Space Industry, was added.

•We have defined the state of Innovation diffusion as the analogy that the company agent is facing the direction of 0 degree the same as the high-tech 1 agent.

•Agent High Tech1 acted in the direction of 0°, and it added the function that made Innovator to 0° direction as a function to transmit an innovation to the Innovator in the field of view within less than 15.



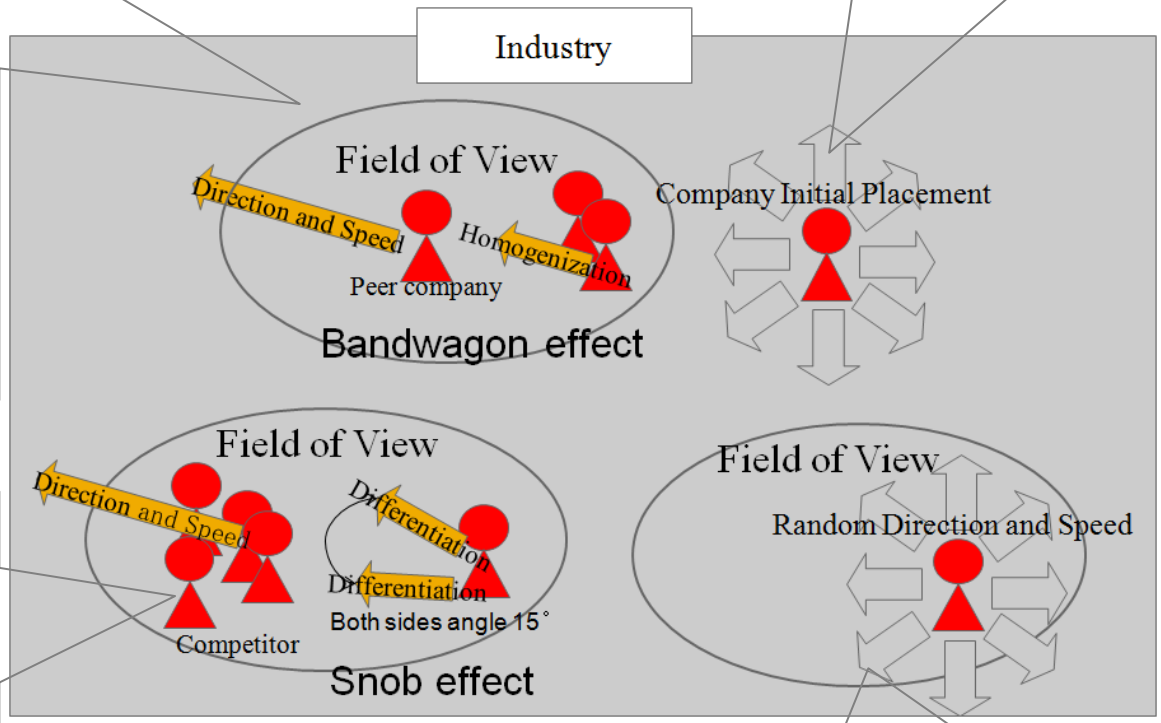

•As an agent showing a company as an Innovator, Early adopter, Early majority, Late majority, and Laggard were added.

•In the same way, type the previous affect the type of after.

# Fig. 3 illustrates the innovation diffusion.

•If more than the fixed number (the number is peer company), of the other agents of the same kind are within the surroundings (width of a view), the company agents take the same direction and speed as the other agents of the same kind, because of the bandwagon effect.
•This action was defined as homogeneous behavior.

At first, random position, direction, and speed was used.

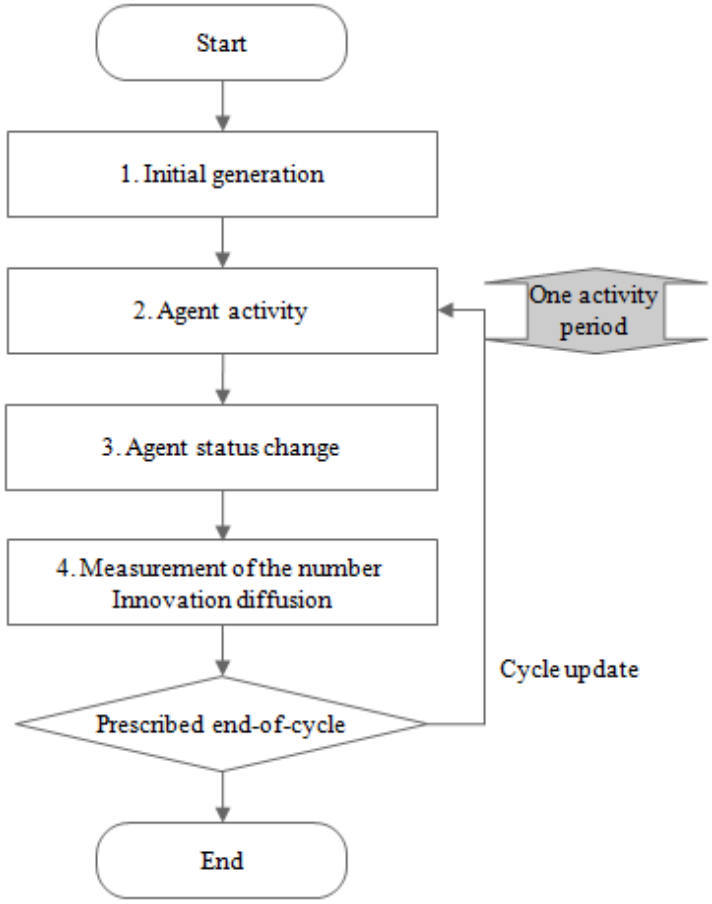



•If more than the number of competitor whose agents of the same kind are in the surroundings (width of the view) , the company agents take the different direction (both side angle 15) and speed as the other agents of the same kind because of the snob effect.

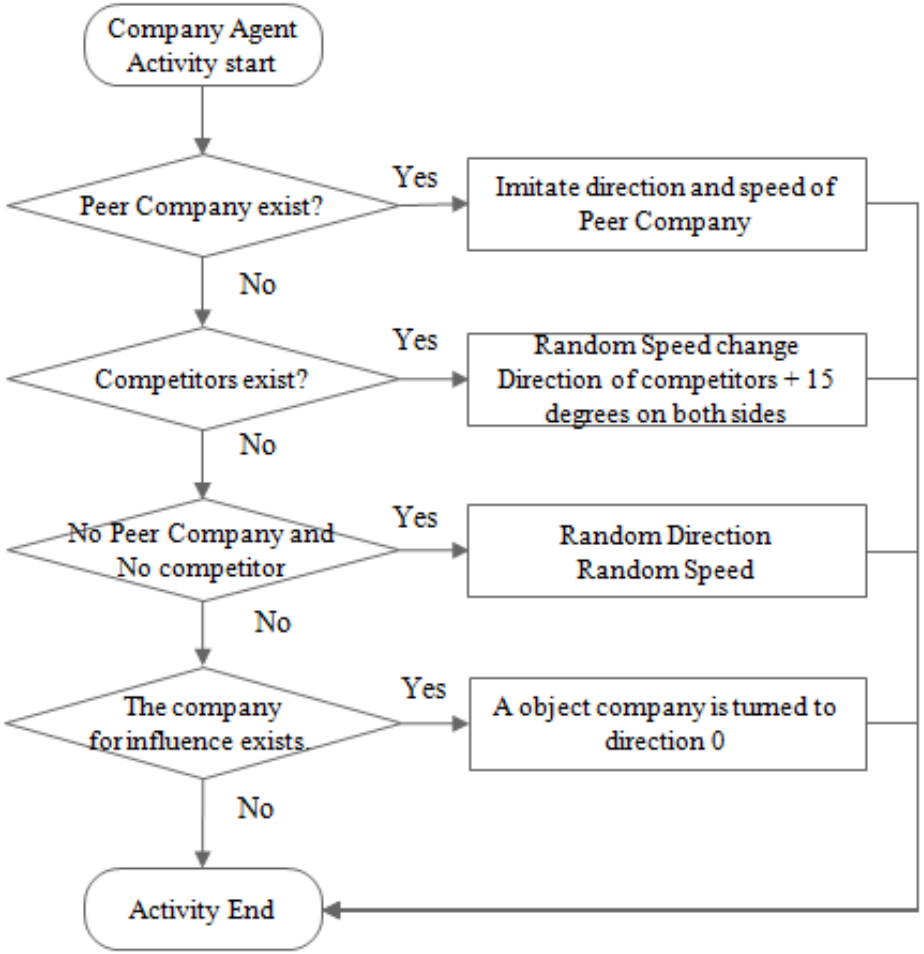
•There is neither a homogeneous partner nor a differentiation partner, change of direction or speed suitably.

# Simulation flow of Innovation Diffusion Model

## Fig. 5. Simulation flow




## Fig. 6. Company Agent Activity Flow

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# Experimental conditions

- We set 200 companies in the same industry with the ratio that Moore [2] proposed.
- The experimental conditions are shown in Table I.
- Based on the above configurations, 10 times trials within each 10,000 steps were operated.
- Figures 7 to 16 show the experimental results.

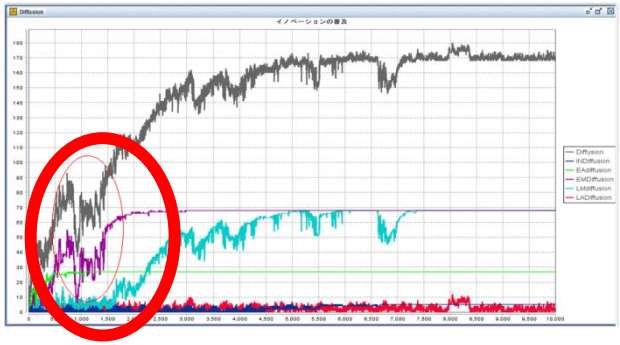
**Table 1. Experimental conditions**

| | Innovator | Early Adopter | Early Majority | Late Majority | Laggard | Total |
|---|---|---|---|---|---|---|
| Width of View | 2 | 2 | 2 | 2 | 2 | - |
| Number of Peer company | 1 | 1 | 2 | 3 | 3 | - |
| Number of Competitor | 10 | 10 | 10 | 10 | 10 | - |
| Existing ratio | 2.5% | 13.5% | 34.0% | 34.0% | 16.0% | 100.0% |
| Number of existence | 5 | 27 | 68 | 68 | 32 | 200 |

# Experimental result

- We succeeded to generate Chasm in 8 trials (Example: Fig.7).

**Fig. 7 Simulation Result (1st trial)**

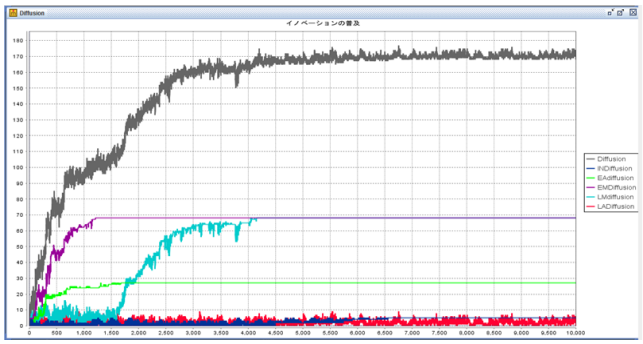


- In two trials, Chasm in the second half could be observed(Example: Fig.9).

**Fig. 9 Simulation Result (3rd trial)**

- Only one trial was not observed in the crack (Example is Fig.10).

**Fig. 10 Simulation Result (4th trial)**



# Concluding remarks

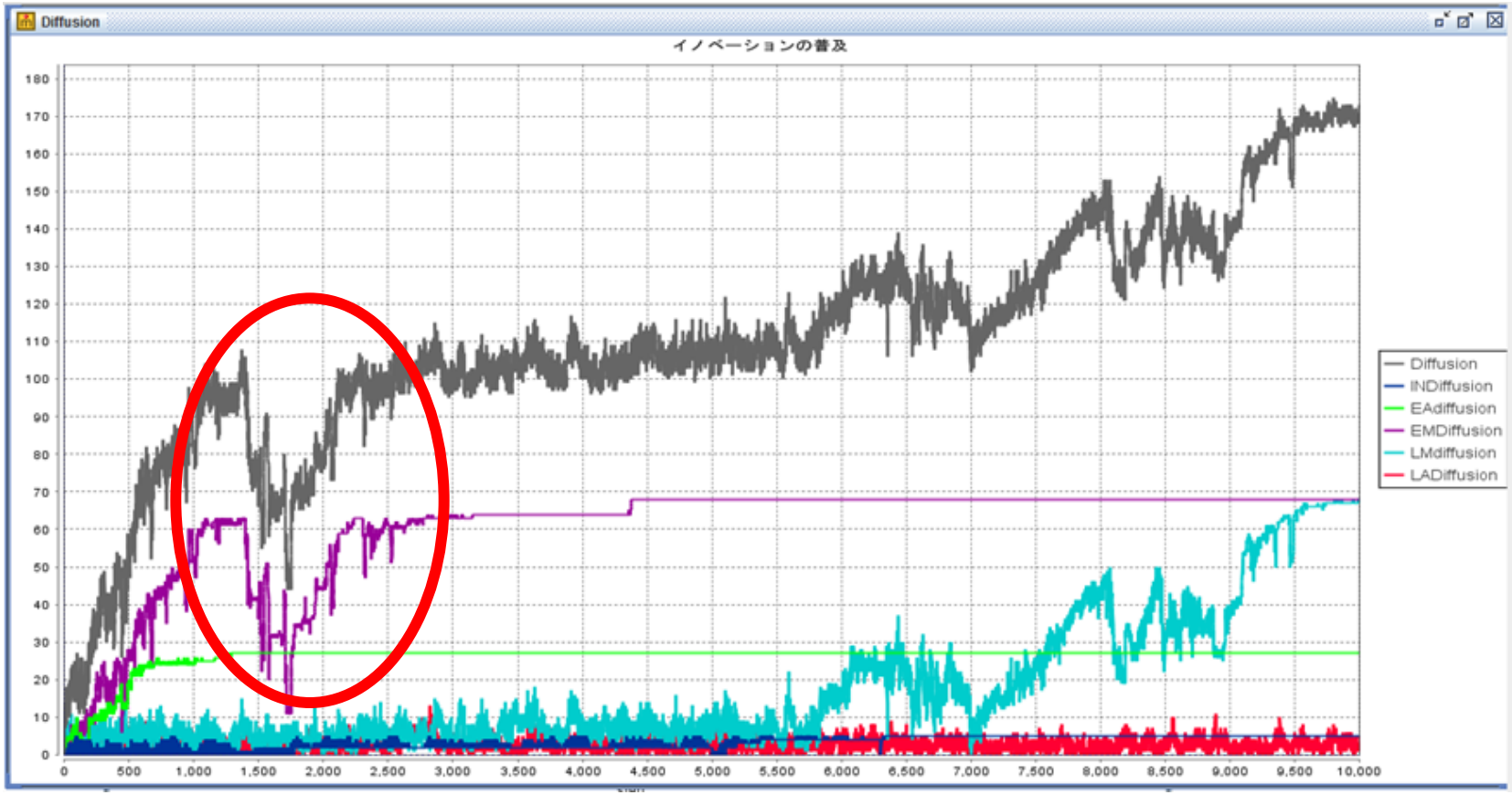
- Based on the innovation diffusion theory, we defined parameters and made a simulator for Chasm observation.
- From the results of the simulation, we succeeded in crack generation.

- Our future work is as follows:
  (a) Capture the conditions for the crack generation
  (b) Parameter tunings of corporate indicators such as sales, costs, assets, and capital and so on
  (c) Compose simulation for a new technology as Innovation goes into the industry

# References


1. H. Matsuoka, “Japanese consumer electronics manufacturers in Asia and white goods market Efforts,” General Foundation Japan Asia Pacific Ocean Institute Macroeconomic Analysis, project, March, 2012.
2. http://www.apir.or.jp/ja/research/files/2013/03/423_02.pdf (accessed on January 25th, 2014)
3. G. Moore, “Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers,” Collins Business Essentials, Harper Business, 1991.
4. Ministry of Economy Trade and Industry, "Survey about mid- and long-term research and development of company in our country which contributes to innovation creation," Industrial Technology Investigation Report in Heisei 23 fiscal year, 2011.
5. http://www.meti.go.jp/policy/economy/gijutsu_kakushin/innovation_policy/kaihatu-hyoka-22.htm (accessed on November 5th, 2013)
6. H. Hasegawa,” Introduction to Venture Management business creation,” Tokyo: Nikkei Publishing Inc., 2010.
7. J. A. Schumpeter, “The Teory of Economic Development:An Inquiry into Projits, Capital, Credit, Interest, and the Business Cycle,” Cambridge: Harvard University Press,1934.
8. Utterback. J. M. and W. J. Abernathy, “A Dynamic Model of Process and Product Innovation."Omega.Vol.3, No.6, ,1975, pp. 639-656.
9. N. Rosenberg, “Inside Black Box: Technology and Economics,” New York: Cambridge University Press,1983.
10. W. J. Abernathy, K. B. Clark, and A. M. Kantrow, “Industrial Renaissance: Producing a Competitive Future for America,” Basic Books.1983.
11. W. J. Abernathy and K. B. Clark, "Innovation: Mapping the Winds of Creative Destruction." Research Policy, vol. 14, no. 1, 1985, pp. 3-22.
12. C. M. Christensen, “The Inovation's Dilemma when New Technologies Cause Great Firms to Fail”, Boston: Harvard Business School Press. 1997.
13. E. M. Rogers, “Diffusion of Innovations,” Glencoe: Free Press., 1962.
14. H. Leibenstein, “Bandwagon, Snob, and Veblen Effects in the Theory of Consumers' Demand,” The Quarterly Journal of Economics vol. 64, no. 2, 1950, pp. 183-207.
15. M, E. Porter, ”What is Strategy” Harvard Business Review, November-December, 1996, pp. 61-78.
16. M. E. Porter, H. Takeuchi, and M. Sakakibara, ”Can Japan Compete?,” Basingstoke Macmillan, 2000.
17. S. Asaba, “Empirical Analysis of homogeneous behavior - Competition of Japanese Companies,” Tokyo: Toyo Keizai Inc., 2002.
18. C. C. Markides and P. A. Geroski, ”Fast Second: How Smart Companies Bypass Radical Innovation to Enter and Dominate New Markets,” John Wiley & Sons, 2004.
19. Y. Washida, ” The heterogeneity of an information propagation network and structural analysis of a value conversion phenomenon in a diffusion process : Possibility of the innovation which the demand side tows,” The University of Tokyo doctoral dissertation, 2008.
20. Y. Washida and K. Ueda, ”Research on the demand side network propagation structure that generates innovation ideas,” Journal of Information Processing of Japan. vol. 49, pp. 1515-1526, 2008.
21. T. Matsuka, Toshihiko, H. Honda, Y. Washida, and K. Ueda, ”Exploratory multi-agent modeling studies examining influence of social structures on development of innovative ideas,” The 27th Annual Conference of the Japanese Society for Artificial Intelligence, 2013, 4F1-4.
22. D. J. Watts and S. H. Strogatz, “Collective Dynamics of Small- World Network,” Nature, vol. 393, pp. 440-442, 1998.
23. A. L.Barabsi and R. Albert, ”Emergence of Scaling in Random,” Network Science, Vol. 286, p509-512 ,1999.
24. H. Kitanaka, “Diffusion of Strategic Innovation and Social Network Structure: A Discussion Using Agent Based Approach,” Takushoku management accounting research,81, 2007, pp.27-63.
25. K. Morioka, ”An understanding by brand value generation and a change, the explanation based on the dynamics social system theory of a market share, and a multi-agent simulation,” The Mita commercial science research, vol. 52, no. 1, 2009, pp. 87-110.

# 図7　キャズム発生の場合
# Fig. 7.  The case of generation chasm





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# 図8　後半にキャズム発生の場合
# Fig. 8.  Chasm in the second half

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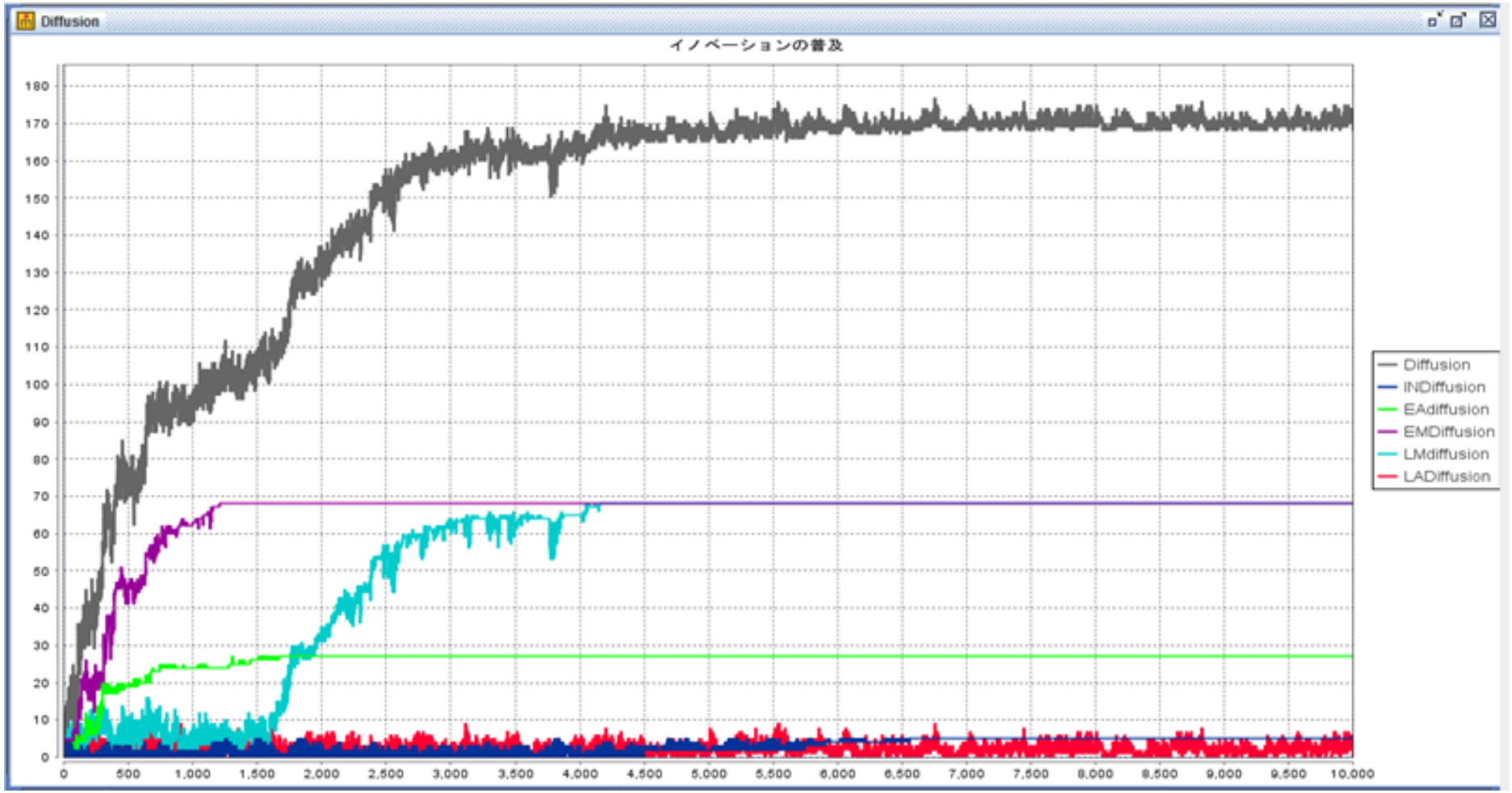
# 図9　キャズム発生しない場合
# Fig. 8.  Case of no Chasm generation





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