

# A paradigm shift to sustainable evolution through creation of universal ties

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An overview of world history after the Industrial Revolution is presented with respect to how it has led us, human beings, to face the problem of sustainability. The process is viewed as a narrowly interpreted Darwinian evolution based on natural selection, where strong groups dominate and take all as winner, wherein the associated expansionism is threatening sustainability. The author proposes an application of self-organization (the bottom-up approach) to higher levels of evolution in society with *ties* as the alternative force to the physical. Successful education for young children by the methods suggested by Montessori, Suzuki and the Early Development Association of Masaru Ibuka may be understood by the self-organization concept with ties in place. The neutral theory of mutation as the prevailing mechanism of molecular-level evolution may be regarded as a bottom-up approach in nature, while Darwinian natural selection works through competition for survival at the upper level, analogously viewed as a top-down approach. In the Edo Period of Japan, the notion of sustainable evolution is found in the Shingaku Movement and the Hotokusha Restoration. At the levels of merchants and farmers, bottom-up approaches successfully proliferated with ties as the driving force. The Toyota Production System initiated by T. Ohno may be regarded as such an approach in modern industry. The Sony Way led by Masaru Ibuka, founder of the company, demonstrated a successful bottom-up approach driven by the strong aspirations of the top management, pushing up the company to world class in a short time. The author expects organized bottom-up approaches (such as the “carve-out” scheme to enhance innovation through creating start-ups) to complement the top-down strategy typically pursued by large corporations and the industrial policies of governments. In the field of healthcare and medication, many top-down population strategies have not, however, been

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successful, resulting in the continuous increase of medical expenditure by households and governments. Implementation of a *sensor network* could lead individuals to bottom-up, self-improvement activities; the “Health Improvement Net Service” recently founded by the author and his colleagues to change the passive social model dependent on medicines and surgery after disease into active health creation and disease prevention has engendered some encouraging phenomena. Today, it seems that there is excessive reliance on top-down approaches; the critical importance of bottom-up approaches is neglected. Although top-down approaches based on power may *seem* efficient, history shows us that they contain risks that could lead the whole world to disaster. Although bottom-up approaches based on universal ties seem to be slow and inefficient, this paper concludes that they are critically important for a paradigm shift to sustainable evolution.

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## 1. INTRODUCTION, SUSTAINABILITY AS A SERIOUS CHALLENGE FOR THE WORLD TODAY

World history seems to have developed under a narrowly interpreted Darwinian evolutionary process of natural selection, which implies that specific individuals adapting to the environment flourished.<sup>1</sup> However, it seems that the idea has been narrowly interpreted to mean that evolution occurs through a fierce struggle for survival, allowing strong groups to win and destroying weak groups, bringing evolution and progress, hence justifying domination of the winners taking all. This process can be viewed as a top–down process, defining the structure of (hierarchical) society from the upper level. The expansionism associated with the concomitant movement toward power and materialistic abundance now seems to threaten world sustainability; human society as well as the natural environment. Human society is now riven by struggles between different cultures. It is also challenged by the north–south division, financial bubble risks and aging societies. The natural environment is threatened by degradation of the air, soil, water and forests as well as the decrease and even extinction of many living species.

In this paper, world history after the Industrial Revolution is reviewed from the aspect of the bottom–up, self-organizing principle governing nanostructures in contrast to general views based on top–down processes in politics and economic systems. Even after many efforts to topple the capitalistic system, or to modify it, the world has not yet found a sustainable solution. The world economy as the base of society is very unstable, always lying at the rim of collapse. The political system as well as world culture as the superstructure is, accordingly, very unstable. These instabilities threaten sustainability.

History contains many top–down approaches that resulted in disasters or collapses. Communist nations that aimed to establish an alternative to the capitalistic system collapsed, starting with the fall of the Berlin Wall in 1989. Keynesian policy to control effective demand either positively or negatively by governments is challenged by the global scale of sovereign debts. There are serious cultural splits with Islamic countries. All these undesirable trends can be contrasted with achievements of the Shingaku Movement<sup>2</sup> and the Hotokusha Restoration<sup>3</sup> in the Edo Period of Japan. The present author proposes that the root cause of instability is narrowly interpreted Darwinian evolution—that the winner can and is allowed to take all through expansionism and exploitation.

Based on molecular-level study, Motoo Kimura proposed the neutral theory of mutation<sup>4</sup> and Tomoko Ohta refined the theory to formulate a widely acceptable set of laws.<sup>5</sup> According to the theory, at the molecular level of genes an enormous number of mutations takes place with slightly negative effects on species survival, as if to allow species to prepare in advance for many environmental changes and adaptation thereto. Whereas natural selection engenders top–down evolution, neutral mutation can be regarded as a bottom–up approach at nanoscale dimensions.

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<sup>1</sup> Darwin, C., *Natural Selection or the Survival of the Fittest*. In: *The Origin of Species*, pp. 76–127. New York: New American Library (1958) (first published in 1859).

<sup>2</sup> Bellah, R.N., *Shingaku and its founder*. In: *Tokugawa Religion*, pp. 133–177. New York: The Free Press (1957).

<sup>3</sup> Bellah, R.N., *Tokugawa Religion*, pp. 126–132. New York: The Free Press (1957).

<sup>4</sup> Kimura, Motoo, Evolutionary rate at the molecular level. *Nature* (Lond.) **217** (1968) 624–626.

<sup>5</sup> Ohta, T., Slightly deleterious mutant substitutions in evolution. *Nature* (Lond.) **246** (1973) 96–98.

One eye-opening perception that nanotechnology has brought into our knowledge is self-organization driven by attractive and repulsive forces naturally incorporated in molecules and atoms, often articulated as the bottom–up process.<sup>6</sup> Humans have developed over history many top–down processes, both societal and technological such as legislative rules defining structures of society, and large-scale integrated circuits (LSIs), defined by system-level description. The self-organization process offers a model of social evolution development driven by attracting or rejecting *ties* among members of society.

In order to recover from the disaster of the Great Tohoku Earthquake and Tsunami, the Japanese Government launched the “Kizuna Project” initiative; the core concept was to enhance recovery by strengthening ties among the people in the area as well as outside, including overseas.<sup>7</sup> As a result many bottom–up projects were organized under the name of the Kizuna Project.<sup>8</sup> Although the Japanese Government interpreted the word “tie” as “bond,” the author employs “tie” for the implication defined in this paper. Although “tie” will be precisely defined in a later section, here it is simply defined as the cooperative relation among people within and across political and cultural boundaries in order to make a better world.

In the isolated Edo Period of Japan (1600–1868), agriculture was self-sufficient and sustainable, nurturing the surrounding environment such as mountains and forests while utilizing excreta of humans and animals as fertilizers.<sup>9</sup> Five traditional agricultural systems in various areas of Japan were certified in 2011 as Globally Important Agricultural Heritage Systems (GIAHS).<sup>10</sup> Although Japan is not by any means an agricultural giant, it has many agricultural models to be emulated in the challenges the world faces, thanks to the efforts of its ancestors.<sup>11</sup>

The Shingaku Movement was initiated by Ishida Baigan.<sup>12</sup> The movement led to the establishment of the concept of public interest, and the firm position of the merchant class, with their guiding principles, embedded in the feudalistic system. Ninomiya Sontoku initiated the Hotokusha Restoration Movement to restore farming villages and avoid death from famines.<sup>13</sup> Both bottom–up movements also influenced the lifestyle of people, leading to lean and sustainable ways of individual living. This way of lean practice prevailed in the country and seems to have been inherited by the Toyota Production System initiated by

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<sup>6</sup> Ramsden, J.J., *Nanotechnology: An Introduction* (2nd edn), Section 8.2. Amsterdam: Elsevier (2016).

<sup>7</sup> Ministry of Foreign Affairs of Japan, *The Youth-Exchange Project with Asia–Oceania and North America* (Kizuna bond Project) [http://www.mofa.go.jp/j\\_info/visit/incidents/kizuna\\_project.html](http://www.mofa.go.jp/j_info/visit/incidents/kizuna_project.html) (April 2012) (accessed 21 May 2016).

<sup>8</sup> Kizuna Sanriku Project, *Kizuna Sanriku Project toha* (What is Sanriku Tie Project?) <http://www.kizuna-sanriku.jp/index.php?syoukai> (accessed 21 May 2016).

<sup>9</sup> Anne McDonald, Luohui Liang and Shimako Takahashi, Japanese agricultural heritage systems recognized. In: *Our World* (<http://ourworld.unu.edu/en/japanese-agricultural-heritage-systems-recognized>, 15 July 2011) (accessed 23 May 2016).

<sup>10</sup> Kazuhiko Takeuchi, *Sekai Nougyou Isan* (Globally Important Agricultural Heritage Systems), pp. 29–34. Tokyo: Shodensha (2013).

<sup>11</sup> Kazuhiko Takeuchi, *Sekai Nougyou Isan* (Globally Important Agricultural Heritage Systems), p. 3. Tokyo: Shodensha (2013).

<sup>12</sup> Hiroshi Eko, Tohi mondou (Questions and answers between men of country and Kyoto). In: *Ishida Baigan*, pp. 83–154. Kyoto: Seishin Keizai Kenkyusho (2005).

<sup>13</sup> Ichiro Kuroiwa, Ninomiya Sontoku-ou to sono yobanashi (Ninomiya Sontoku and his evening stories). In: *Ninomiya Sontoku Yobanashi*, pp. 17–36. Tokyo: Meirin Shuppansha (1966).

Taiichi Ohno.<sup>14</sup> This system pushed Toyota to become a world class company and inspired many researchers throughout the world to come up with new concepts of business management in industry.<sup>15, 16</sup> In the meantime, the Sony Way was launched by Masaru Ibuka, founder of the company.<sup>17</sup> This style of management, allowing enormous freedom based on firm ties among employees, was an antithesis to the generally practised top–down control in business management. However, it led the company to become a world class entity with many remarkable successes.<sup>18, 19</sup>

Ibuka applied the idea to the education of infants within the Early Development Association he founded.<sup>20, 21</sup> Many experiments were conducted with the voluntary cooperation of mothers, either pregnant or having infant children, resulting in quite a few surprising discoveries;<sup>22, 23</sup> it was an antithesis to the top–down teaching of knowledge generally practiced in education. He strongly resonated with Shinichi Suzuki, who founded the Talent Education Research Institute,<sup>24</sup> where children learn to play the violin from a very early age. The style is now called the Suzuki Method. Children are never forced to play the instrument unless they show an interest.<sup>25</sup>

While Ibuka focused on the foetus and infants, and Suzuki concentrated on music, Maria Montessori had pioneered the field of education for young children since the beginning of 21st century.<sup>26</sup> She developed her original ideas—often called the Montessori Method—to allow freedom of children and encourage self-development. She devised many working tools

<sup>14</sup> Japan Management Association (ed.) (transl. D.J. Lu), *The source of profit is in the manufacturing system*. In: *Kanban, Just in Time at Toyota*, pp. 3–22. Cambridge, Mass.: Productivity Press (1986).

<sup>15</sup> Hiroshi Kato, Shin nakuba tatazu, yakusha no kotoba (No society exists without trust. In: *Shin Nakuba Tatazu*, pp. 3–12. Tokyo: Tuttle-Mori Agency, Inc. (1996) transl. from F. Fukuyama, *Trust: The Social Virtues and Creation of Prosperity*. Free Press Paperbacks (1995).

<sup>16</sup> Bhamu, J. and Singh Sangwan, K. Lean manufacturing: literature review and research issues. *Intl J. Operations Production Management* **34** (2014) 876–940.

<sup>17</sup> Sony Corporation, *Founding Prospectus* (<http://www.sony.co.jp/SonyInfo/CorporateInfo/History/prospectus.html>) (accessed 19 May 2016).

<sup>18</sup> Hiroshi Goto, Kyusoku seicho kigyou, Sony (Sony, the Rapid Growth Company). In: *Sony no suji (Figures of Sony)*, pp. 11–24. Tokyo: Dobunkan Shuppan Kabushikikaisha (1967).

<sup>19</sup> Sony Corporation, *The History of Sony* (<http://www.sony.net/SonyInfo/CorporateInfo/History/SonyHistory/>) (accessed 19 May 2016).

<sup>20</sup> Sony Education Foundation, *Ibuka Masaruto Kyoiku Josei* (Masaru Ibuka and Education Aid) (<http://www.sony-ef.or.jp/sef/about/founder.html>) (accessed 21 May 2016).

<sup>21</sup> Masaru Ibuka, *Youchien Karadeha Ososugiru*. Tokyo: Goma Shobo (1971), transl. as *Kindergarten is too Late*. New York: Simon and Schuster (1977).

<sup>22</sup> Youji Kaihatu Kyokai Foundation (Early Development Association Foundation), *Ibuka Masaru no Youji Kyoiku Goroku* (Words of Masaru Ibuka on Early Child Education), pp. 231–232. Tokyo: Goma Shobo (1998).

<sup>23</sup> Masaru Ibuka, Hahato kowo musubu shinpino kizuna (Mysterious tie between mother and foetus). In: *Taijiha Tensaida* (Fetus is Genius), pp. 18–39. Tokyo: Chikuma Shuhansha (2002).

<sup>24</sup> Talent Education Research Institute, *Suzuki Method* (<http://www.suzukimethod.or.jp/indexE.html>) (accessed 19 May 2016).

<sup>25</sup> Shinichi Suzuki, Hajimeni (Introduction). In: *Ai ni ikiru* (Living in Love), pp. 10–13. Tokyo: Kodansha (1966); see also *Nurtured by Love: The Classic Approach to Talent Education* (transl. W. Suzuki). Los Angeles: Alfred Music (1986).

<sup>26</sup> Montessori, M., The child's part in world reconstruction. In: *The Absorbent Mind*, pp. 3–9. New York: Henry Holt (1995).

developed through her experience with children. It was quite surprising to her that, after completing work on tools, a child would emerge with almost a completely different personality. The child became now confident, well able to understand the teacher's instructions, cooperative, and sympathetic with other classmates.<sup>27</sup> She called this change "normalization".<sup>28</sup>

The author would regard this change as a self-organizing process within the child. Through receiving many unorganized inputs, the child must have found the surrounding world very confusing, and expressed frustration by crying or other naughty actions. Through learning and working on tools motivated by its own interest, the child develops ties with surrounding environment, including teachers, classmates and the child itself. Any disturbance of the process would be harmful (as in the self-organization of nanostructures). After repeating the work many times, the internal (neural) circuitry develops correspondingly and thus the child gains stable and interactive relations with its environment and with itself, namely *tie formation*.

In industry, as Schumpeter pointed out,<sup>29</sup> large business entities tend to lose their momentum of innovation, whereas individual researchers tirelessly seek ways to commercialize their innovative research outputs. In order to finance such researchers' efforts and, consequently, animate the industry, the author and his colleagues raised a fund under the "Technology Carve-Out Investment Partnership".<sup>30</sup> Many researchers are motivated to address sustainability through technology.<sup>31</sup> So, one of the expectations from raising such a fund was to allow them to create ties with a broad field of people to overcome their challenges, encouraging a bottom-up approach.

It is widely held that there is an urgent necessity to change the current passive social model depending on medicines and surgery after diseases into an active one of health creation and disease prevention.<sup>32</sup> The Sensor Network Study Project hosted by the Japan Techno-Economics Society (JATES) concluded that self-improvement activities such as exercises and control of salt intake are indispensable for such a transformation and, furthermore, that the Sensor Network should be utilized to activate such a bottom-up approach.<sup>33</sup> To realize the project, "Health Improvement Net Service LLC" (HINETs), a sensor network service company, was founded by the author and his colleagues.<sup>34</sup> Real-time sensing of individuals offers them opportunities to work

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<sup>27</sup> Montessori, M., Pampered children. In: *The Secret of Childhood*, pp. 143–147 (transl. J. Costelloe). New York: Random House (1966).

<sup>28</sup> Montessori, M., Normalization. In: *The Secret of Childhood* (transl. J. Costelloe), p. 148. New York: Random House (1966).

<sup>29</sup> Schumpeter, J.A., *Capitalism, Socialism, and Democracy*, pp. 131–132. New York: Harper & Row (1975).

<sup>30</sup> Watanabe, S., Masuya, H. and Kato, S., Carve-out scheme to develop technology-driven strategic businesses. *Proc. PICMET '14, Japan*, pp. 822–829 (2014). See also §11.

<sup>31</sup> Watanabe, S., Masuya, H. and Kato, S., Fund management for carve-out start-ups, a scheme to lead innovations outside the business scope of large corporations. *Proc. PICMET '16, Hawaii*, pp.1286–1294 (2016).

<sup>32</sup> Matsumoto, Ch., Hajimeni (Preface). In: *Kenko Koudou Riron no Kiso (Basics of Health Behaviour Theory)*, p. iii. Tokyo: Ishiyaku Shuppan Kabushikigaisha (2002).

<sup>33</sup> Japan Techno-Economics Society (JATES), *IT ni yoru yobougata iryo he muketa sangyoshiten no rohdo mappu sakusei (Roadmap from the Industrial Viewpoint for Preventive Medicine Utilizing Information Technology)*, pp. 158–163. Tokyo: JATES (2012).

<sup>34</sup> Kenko Zoshin Net Service Godo Kaisha (Health Improvement Net Service, LLC), Kaisha gaiyo (about the company) ([www.hinets.jp/](http://www.hinets.jp/)) (accessed 6 Jan. 2016).

closely with their own health, namely to create ties with themselves and with those working to address the same challenge.<sup>35</sup> Excessive reliance on top–down approaches should be redirected; the tie-based bottom–up approach needs to be applied to all aspects of our current social systems. Through such efforts, a paradigm shift to sustainable evolution could be realized.

## **2. AN EVOLUTIONARY OVERVIEW OF WORLD HISTORY AND THE CHALLENGE FOR SUSTAINABILITY**

This paper is confined to reviewing history from the viewpoint of top–down and bottom–up approaches rather than discussing in depth the philosophies and theories that emerged in the process of modernization of the world. It particularly calls attention to the lack of the tie-based bottom–up approach in the present world.

### **2.1 The Industrial Revolution and the consequent globalization and exploitation**

The Industrial Revolution endowed industrial leaders with enormous power. The bottom–up power of industrialists changed the political system to reflect their interests through parliaments of elected representatives. At the political level, the advanced nations employed expansionism and colonized many territories. As a result, these colonial areas lost their autonomy, through incorporation into the global supply chain (the First and Second World Wars may be understood as an explosion of conflicting interests among such colony-controlling nations). It seems that narrowly interpreted Darwinian natural selection—letting the winner take all—worked as the underlying principle. At least, such a process was regarded as acceptable.

During that epoch, exploitation was commonly seen as a top–down practice in the society of such early capitalistic countries. Thus labourers, including women and even children, were entrained into massive exploitation. It is clear that labourers were positioned as the workforce in order to carry out simple work defined by the capitalists. This concept later went further to the extent of the Taylor system, in which work is divided into small pieces, excluding the possibility of any bottom–up improvements.<sup>36</sup>

### **2.2 Marxism and the collapse of the grand historic challenge**

In order to change the social system, quite a few social movements emerged. Among them, Marxism, effectively launched by Karl Marx and Friedrich Engels, was the most influential.<sup>37</sup> It explained history by the concept of dialectic development of social systems. It defined the superstructure of society, namely politics and cultures, driven and defined by the progress of the base or the substructure, namely the economy. The problems within capitalistic society were explained through the contradiction generated within the substructure and consequently threatening the defined and ongoing superstructure. Marxism asserted that exploitation of labourers would be abolished when they win the class struggle against the capitalists and gain

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<sup>35</sup> Watanabe, S., Tanii, Y. and Ono, M., Network service to enhance self-improvement activities for health, a challenge to change passive social model to active health creation and disease prevention. *Proc. PICMET '16*, pp. 3094–3105 (2016).

<sup>36</sup> Taylor, F. W., *The Principles of Scientific Management*. New York: Harper & Brothers (1911).

<sup>37</sup> Marx, K. and Engels, F., “Bourgeois and Proletarians.” In: *The Communist Manifesto*, pp. 3–13. London: Merlin Press (2013) (first published in 1848).

power.<sup>38</sup> The concept, together with the associated movement, was so influential that it drove revolution in Russia, to found a country based on communism and the controlled economy proposed by Marx. The world was thereafter split into two, one side employing capitalism and the other Marxism. The struggle between the two sides lasted until the latter collapsed in the early 1990s, starting with the fall of the Berlin Wall in 1989. Thus, the grand historic challenge failed in the end.<sup>39</sup> It is worth noting that the problem of the social system was interpreted as a conflict of interest between classes and that winning the class struggle by labourers was seen as the solution. Admittedly, as the substructure develops in the way of evolutionary processes, contradiction in the traditional superstructure becomes clear, generating driving forces for change. However, the idea of class struggle seems to reflect the narrowly interpreted Darwinian theory of natural selection and, hence, it may be questioned whether the class struggle really has been the driving force of many evolutionary changes of society. Self-organizational, bottom-up processes are observed in historic changes as well. The class struggle concept can be contrasted with the Shingaku Movement, where indispensable roles of different classes were defined as contributors to public life and well-being.

### **2.3 Innovation and evolutionary process in the capitalist system**

Josef Schumpeter launched the perception that the fundamental nature of capitalism lies in innovation and inherent evolutionary processes.<sup>40</sup> He pointed out that capitalism works only when the evolutionary process is realized by courageous entrepreneurs through innovations. He asserted that the capitalist system would inevitably become inactive through the bureaucratic decision-making that develops in large companies even if they had once been filled with entrepreneurs.<sup>41</sup> He predicted that growth becomes slower and that society would become socialistic. His point that the entrepreneurs and associated innovation constitute the fundamental condition for maintaining the active evolutionary processes of the capitalistic system is regarded as correct even today, and how to activate innovation is now the top concern for industry leaders and politicians in advanced countries.

If the core strength of capitalism lies in the evolutionary process driven by innovations, then it may be questioned where the evolution should be directed and how the evolutionary process can be managed or at least influenced to head toward desirable directions. It may even be questioned which directions are desirable. The questions would include how such direction can be imposed in a free economy working under the political principle of popular self-determination. It is widely opined that the world is challenged by sustainability; the present author's point is that the direction of sustainability can be realized through bottom-up approaches to create universal ties. With reference to the cases of Toyota and Sony, strength in

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<sup>38</sup> Marx, K. and Engels, F., "Proletarians and Communists." In: *The Communist Manifesto*, pp. 13–20. London: Merlin Press (2013).

<sup>39</sup> Albeit that in the decade preceding the fall of the Berlin Wall, commentators were wondering which would collapse first—capitalism or communism? The fact that it was the latter may have been almost fortuitous.

<sup>40</sup> Schumpeter, J.A., "The Process of Creative Destruction," in [29], pp. 81–86.

<sup>41</sup> Schumpeter, J.A., "Crumbling Walls," in [29], pp. 131–142.



the activities of people gained through the tie-based, bottom–up processes would allow for many effective options in top–down strategies for politics and the economy.

## **2.4 Keynesian modification of capitalism and its limitations**

Traditionally it was believed that the market mechanism works such that the capitalistic system operates reasonably well, despite periodical ups and downs. However, the great depression starting in 1929 presented a disastrous situation, revealing that the market mechanism alone was not sufficient for sustaining the economy, not to mention growth. J.M. Keynes devised a theory that the economy can be managed better by controlling demand and that such control can be effected via government expenditure. In his theory, control should work in two directions, positive to increase expenditure to multiply active demand and avoid deflation, and negative to decrease it when the economy is expanding. So, this was a way to justify intervention by the government and connect the economy to politics. However, politically it is not easy to step on the brakes once expenditure is expanded. Thus, many countries have accumulated huge sovereign debts. The situation has brought the risk of default of many governments and the global financial crisis. Recent history shows that nowadays a “sovereign” power cannot defend itself against attack from a huge financial power such as a gigantic hedge fund. Hence, although Keynesianism offered a certain remedy aimed at avoiding crises of the capitalistic system, it is not sufficient for the challenges the world faces today.

## **2.5 The role of finance**

After the Second World War, the United Nations was formed and the principle of self-determination of people was declared in Article 1 of the Charter.<sup>42</sup> However, as economic globalization proceeds, a new form of exploitation seems to have emerged in the form of financial capital growth. Recently, Thomas Piketty studied the history of this growth and found that the real economy has recorded a much lower growth rate than the rate of capital cost,<sup>43</sup> implying that wealth is being accumulated by a diminishing number of capitalists. The result is division of society and instability of the economy due to excess liquidity. The world now looks as though it is playing the “Whac-A-Mole” game against the collapse of economic bubbles. Such bubbles can easily be formed in the capitalistic system under conditions of excess liquidity.

Needless to say, we live in the real economy. Although finance is indispensable for the economy to work well, its role should be confined to help the real economy for the benefit of the public. In order to bring in the financial side to the real economy, active entrepreneurship is necessary. To repeat: the point of this paper is that such entrepreneurship can be enhanced by the activation of bottom–up approaches through the creation of universal ties.

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<sup>42</sup> United Nations Charter, Article 1 (<http://www.un.org/en/sections/un-charter/un-charter-full-text/index.html>) (accessed 19 May 2016).

<sup>43</sup> Piketty, Th., *The Capital/Income Ratio over the Long Run*. In: *Capital in the Twenty-First Century* (transl. A. Goldhammer), pp. 164–198. Cambridge, Mass.: Belknap Press (Harvard University Press) (2014).

### 3. THE THEORY OF NEUTRAL MUTATION AS THE DOMINANT PROCESS OF EVOLUTION

The neutral theory of mutation as the dominant process of evolution based on the “molecular chronometer” was accepted after enormous research work and protracted argument.<sup>44, 45</sup> The process may well be regarded as a bottom–up approach in nature, allowing species to prepare for environmental changes with molecular-level diversity of their genes. This process of evolution contrasts with narrowly interpreted Darwinian natural selection, where an individual with superior genes dominates within its species through fierce struggles for survival as a top–down process.

The neutral theory of molecular evolution explains that these molecular-level changes progress at a nearly constant speed regardless of whether a species is large (i.e., numerous) or small. For this reason it is called the molecular chronometer. The process represents a bottom–up approach in the molecular scale. In large-scale species the propagation of the change takes time while the lifetime of such species is generally short. In small-scale species, the propagation is rapid while the lifetime is generally long. As a result, the molecular chronometer causes evolution by species-wide gene drifts at a nearly constant speed.<sup>46</sup>

The impact of the theory was to call into question the hitherto widely believed principle of natural selection that had justified many social practices allowing the superior being to dominate and the notion that such practices should be accepted as necessary for the progress of the world.

However, in large and long-lived species like humans, forming societies, the molecular chronometer may not work as in other species. The challenge is how, then, to effectively adapt or prepare for future crises in society caused by changes that may be exogenous.

### 4. SELF-ORGANIZATION OR THE BOTTOM–UP APPROACH IN CONTRAST TO THE TOP–DOWN

The characteristics of self-organization can be summarized as follows:<sup>47</sup>

- (1) Ordered structures are formed automatically without definition or control at higher levels;
- (2) Repulsive or attractive forces between constituent elements such as atoms and molecules with their specific geometrical shapes drive the formation of higher-level structures in the bottom–up approach;
- (3) Disturbance, even if small, during bottom–up formation causes serious disorders.

An illustrative example in nature is the formation of hexagonal snow crystals that take place when small water particles fall down in a cold and humid atmosphere.<sup>48</sup> Not all the crystals are perfectly hexagonal, indicating disturbances during crystal formation. In the living body, protein formation by folding a string of amino acids derived by transcription and translation from DNA<sup>49</sup> is another example of self-organization.

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<sup>44</sup> Kimura, Motoo, The neutral theory of molecular evolution and the world view of the neutralists. *Genome* **31** (1989) 24–31.

<sup>45</sup> Kimura, Motoo, Preponderance of synonymous changes as evidence for the neutral theory of molecular evolution. *Nature* (Lond.) **267** (1977) 275–276.

<sup>46</sup> Tomoko Ohta, Keitai shinkato hobo churitsu setsu (Nearly neutral theory of molecular evolution and evolution of expression). In: *Bunshi Shinka no Hobo Churitusetsu* (Nearly Neutral Theory of Molecular Evolution), pp. 130–134. Tokyo: Kodansha (2014).

<sup>47</sup> Ramsden, J.J., *Bioinformatics: An Introduction* (3rd edn), pp. 29, 127. London: Springer (2015). See also [6].

<sup>48</sup> Holland, W.P., Snowflakes. *Nanotechnol. Perceptions* **3** (2007) 3–14.

<sup>49</sup> Ramsden, J.J., *Bioinformatics: An Introduction* (3rd edn). London: Springer (2015).

An example of top–down nanostructure formation is large-scale semiconductor integrated circuits (LSIs).<sup>50</sup> The function is first defined at system level and then the logic circuit is synthesized, followed by design of a real circuit composed of transistors and other electrical devices with metal interconnexions. From the real circuit, a set of photographic mask patterns are generated and photomasks are fabricated. Through optical lithography and other processes such as etching, diffusion of impurities and deposition of thin films, LSIs or large scale integrated circuits are formed.<sup>51</sup> Such top–down products are ubiquitously incorporated in our tools like computers and networks. Today the smallest feature dimension of such a device is around 10 nm, comparable to the size of large organic molecules.

Many efforts have been made to apply self-organization to industrial products to overcome the dimensional limitation. Tissue engineering for living bodies is an example, and application in many new areas is awaited.

## 5. THE TIE AS THE DRIVING FORCE FOR BOTTOM–UP SELF-ORGANIZATION IN HUMAN SOCIETY

The challenge for the author is now to apply the self-organization process in nanostructures to human society. Since it could be a subject of hitherto uncultivated research in sociology, the author welcomes any comments and criticism from specialists in related fields. There are top–down practices as well as bottom–up efforts for the purpose of realizing a better world in the process of social evolution. The top–down approach would include such activities as politics and business management. The bottom–up approach would include, for example, voluntary movements in society and activities organized for productivity and quality improvement in business. A well-known example of the latter is the QC Circle (Quality Control Circle) movement launched by W. Edwards Deming and widely practiced in Japan, definitely contributing to high quality products. Toyota’s Kanban system of production is another: each worker decides what to do based on the tool required to connect the previous work with the following. “Kanban” originally meant a signboard for shops to put up in their entrances. In the Toyota system, it is a tool to show the status of the following work stage.<sup>52</sup> It is the core of the “pull” production system, instead of the traditional “push”, controlling the amount of production from the last stage of work—ultimately the demand from the customer—and thus the amount of work-in-process is controlled to the minimum, avoiding overproduction, saving the cash needed for in-process inventories and allowing a quick response to the market. In both QC Circle and Kanban, it should be noted that activity is based on ties; ties between circle members in the former and ties along the production line to the customer in the latter, thus connecting workers for a common purpose.

The top–down approach often *seems* efficient. However, the consequences are not always visible. Sometimes it brings about undesirable and catastrophic developments such as division of people, discrimination, destruction of cultures and even wars. In contrast, an advantage of the

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<sup>50</sup> Ovechkin, Yu., *Microelectronics*. Moscow: Mir Publishers (1986).

<sup>51</sup> Mamalis, A.G., Markopoulos, A. and Manolakos, D.E., Micro and nanoprocessing techniques and applications. *Nanotechnol. Perceptions* 1 (2005) 63–73.

<sup>52</sup> Japan Management Association (ed.) (transl. D.J. Lu), The source of profit is in the manufacturing system. In: *Kanban, Just in Time at Toyota*, pp. 81–85. Cambridge, Mass.: Productivity Press (1986).

bottom-up approach is clear visibility of the near future and steadiness of progress, even if it may sometimes be slow and requires the intensive efforts of all people involved. Such an approach becomes very effective with strong aspirations. Because of the necessity of intensive and consensus-based efforts from many people, the approach should be effective for promoting evolution toward sustainability.

Tie formation starts from acceptance of co-existence through mutual understanding and literacy. Then it develops into collaborative working for common purposes. As a trilateral relation (Fig. 1), such collaborative working then promotes, in turn, literacy through experience-based knowledge and mutual understanding of people from different cultural backgrounds. Literacy has been developed through the entire accumulated intellectual workings of our predecessors and helps mutual understanding and creating ties.

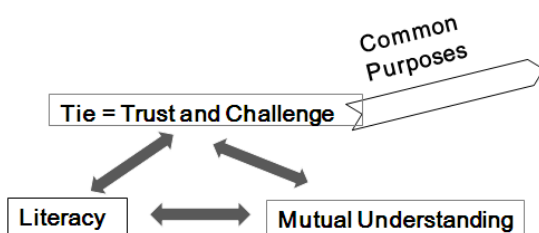


Figure 1. The relation of the tie in the presence of a common purpose with literacy and mutual understanding.

The tie itself is initially a neutral relationship, and when common purposes are shared at higher levels, such as social, it extends beyond communities, societies and cultures, and thus becomes universal. The tie can further be made with living creatures as well as nature as whole, for the purpose of sustaining the diversity of living creatures and of the natural environment.

Regarding the decision-making powers of an individual, it is understood that the association area of the cerebral cortex in the brain integrates information taken from sensing organs, feedback from motion organs, memories throughout the body together with an imagined future picture. It is shown schematically in Fig. 2. The association area of the cerebral cortex refers to the (e)valuation function to weigh the critical importance of each piece of information and alternative actions. Then it generates a set of orders for action through motion organs. Thus, in the brain a bottom-up process takes place prior to the top-down decision-making and action. The feedback from the results of the action in turn affects further modification of the evaluation function as in an evolutionary process.

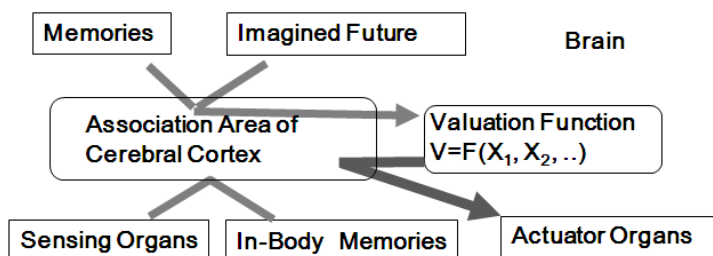


Figure 2. Brain function with the association area of the cerebral cortex and the evaluation function.

## 6. THE MONTESSORI METHOD, THE SUZUKI METHOD AND EARLY DEVELOPMENT ASSOCIATION AS PROCESSES OF SELF-ORGANIZATION WITHIN A CHILD THROUGH THE CREATION OF TIES

### 6.1 The Montessori Method

Maria Montessori was the first female medical doctor qualified in modern medical science in Italy. However, the first job assigned to her was to take care of children in a district of poor people. There, children had not been well cared for and showed signs of confusion. She offered a variety of working tools to them and selected those most appealing to the children. She discovered that they dramatically changed through working with these tools. As an example, a tool consisted of a board with round holes of different sizes and corresponding cylinders to fit into the holes.<sup>53</sup> When a child showed interest in the tool, Montessori demonstrated how to work with the tool slowly and systematically. The child would then itself work on the tool with many trials and errors until the task was accomplished. Even after the first achievement, the child would repeat the work many times until it was satisfied. No intervention was allowed. To the surprise of the teachers, the child emerged with a completely different personality: filled with confidence and able to associate with classmates. The child would now listen to teachers and behaved cooperatively. Montessori called this change “normalization”, meaning that the nature of the child had been distorted by past experiences and that now the child recovered its originally endowed nature.<sup>54</sup> Over the years she developed many such tools and organized a set of principles for children’s education that later came to be known as the Montessori Method.

The process observed in the Montessori Method can be understood in terms of the self-organization of nanostructures. It is also in line with contemporary knowledge of how the association area of the cerebral cortex develops as the centre for all human functions. It can be interpreted as follows:

(a) The self-will of the child is essential in the teaching process for initiation of the self-organization process. Any enforcement or urging is prohibited, considered as a disturbance to the self-organization that goes through an orderly and stepwise development within a child;

(b) The demonstration by the teacher is recognized by the mirror neurons of the child, which makes it easy to follow the motion;<sup>55</sup>

(c) The first success of the work gives self-confidence to the child;

(d) Through repetition of the work, the functions of sensing organs, including feeling the surface and the weight, visually estimating the size and the shape, and actuating organs such as muscles, together with memories of all kinds in the body, develop in an orchestrated manner until the internal processes are fixed as neural circuits inside the child. The association area of the cerebral cortex of the brain works actively to imagine the future and make decisions with reference to the evaluation function, which is developed and refined through the repetition;

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<sup>53</sup> Stephenson, M.E., Foreword. In: *The Secret of Childhood*, by Maria Montessori (transl. J. Costelloe), pp. xi–xxi. New York: Random House (1966).

<sup>54</sup> Heiland, H., Casa dei Bambini. In: *Maria Montessori*, pp. 54–64. Hamburg: Rowohlt Taschenbuch Verlag (1991).

<sup>55</sup> Sagara, A., Teiji toiu kangaekataga nouni kiitayoudesu (Presentation seems to have affected brain. In: *Montessori Kyoikuwo Uketa Kodomotachi (Children who Learned through the Montessori Method)*, pp. 129–153. Tokyo: Kawade Shobo Shinsha (2009).

(e) It can be concluded that the world for the child changes from one of confusion to one of order—with *ties*, ties not only with teachers and classmates but also with surrounding objects. Thus the child becomes cooperative with teachers and friendly with classmates. The process could be interpreted as self-organization driven by internal forces.

## **6.2 The tie as the hidden essential factor in the Montessori Method**

Among her experiences with children, Montessori reveals an episode where she was demonstrating how to blow one's nose elegantly.<sup>56</sup> Children praised the lesson with applause. She was strongly moved to find how much they appreciated her attitude (treating them as dignified individuals). It was a discovery that even for such young people, human dignity was indispensable. For sure food and other materials are an essential necessity for human survival; however, the dignity of each individual is also essential for sustaining mental and emotional life. The tie is another essential factor for an individual to develop himself and drive the evolution of society.

## **6.3 The Suzuki Method—learning to play music from early childhood**

Shinichi Suzuki (1898–1998) was born into the family of a violin craftsman. He learned to play the violin and founded the “Talent Education Research Institute”.<sup>25</sup> There he offered violin lessons for children from infancy (now well known as the “Suzuki Method”). Masaru Ibuka met Suzuki and was impressed with how well the children, who could not yet even speak well, played music. Ibuka and Suzuki resonated with each other at once, sharing a common aspiration.

According to Suzuki, learning from the stage of infancy promotes total development of a child: not only music skills but also warm-hearted thinking.<sup>57</sup> The remarkable development may be attributed to ties with the music instrument as well as with classmates, parents and teachers. He wished that his efforts would be rewarded by realization of the peace of the world when the children grew up, freed from confused views of the rest of the world, like Montessori's “normalization”. Today the Suzuki method is practiced all over the world. Many of those who experienced the class as children now play important adult roles in a variety of fields.

## **6.4 The Early Development Association founded by Masaru Ibuka**

Ibuka's aspiration was to work with infants at the stage of unlimited capability of absorption—during infancy and even before that, during the mother's pregnancy. For him the challenge was to implant creativity and warm-hearted thinking in them, the most important heritage for the future.<sup>20</sup>

In 1959 Sony launched a programme fostering creative activities in science education in elementary schools, in accordance with the declaration in the founding prospectus to promote education among the general public. From the beginning many schools applied to join the programme, and Ibuka had the opportunity to meet and talk with many enthusiastic children.<sup>20</sup>

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<sup>56</sup> Heiland, H., *Maria Montessori*, pp. 50–54. Hamburg: Rowohlt Taschenbuch Verlag (1991).

<sup>57</sup> Shinichi Suzuki, Maegaki (Preface). In: *Ai ni ikiru* (Living in Love), pp. 3–5. Tokyo: Kodansha (1966). Transl. by W. Suzuki as *Nurtured by Love: The Classic Approach to Talent Education*. Los Angeles: Alfred Music (1986).

He was profoundly moved by how creative these children could be when an appropriate environment allowed them to unleash their capabilities, just as he had experienced with engineers (to be described in §10.1).

Ibuka founded the Early Development Association,<sup>20</sup> to which mothers or mothers-to-be were invited and together many kinds of experiments were conducted. As a result, many surprising discoveries were reported.<sup>22</sup> His efforts have been continued by the Sony Education Foundation. Challenges still remain for those inspired and motivated by his aspiration.

## 7. EVOLUTION OF HUMAN SOCIETY THROUGH TIES

Here is a model for social evolution. Firstly, for humans, biological evolution takes place slowly and societal evolution is dominant.

The generally perceived human functions were shown in Fig. 2.<sup>58</sup> The association area of the cerebral cortex of the brain processes sensed information together with memories and internally sensed data with reference to the internally developed evaluation function. The association area generates candidate actions based on the above sensing and referencing. Decisions are made by taking into account the imaginable future resulting from the specific action and the evaluation function.

The evaluation functions are referred to when the association area makes a decision based on all consolidated inputs. The functions reflect the sense of value developed within each individual being through personal experiences as well as the collective memory of the community that may go back many years, even millennia. When senses of value of different individuals are similar, mutual understanding is easy and a cooperative tie would be readily formed. When they are far apart, representing different cultures, they may cause mutual rejection. However, when the tie is successfully formed between diverse cultures, the evolutionary change could be substantial and society as a whole might acquire valuable new guiding principles.

Natural selection among strong powers guided by expansionism has occurred with wars as a consequence. Although such expansionism has contributed to the spreading of the guiding principles of the winner, it can be presumed that the major evolutionary changes have occurred by challenges of many people inspired by ties through bottom-up processes.

An intimate example of tie-driven evolution is found in the influential book *The Reason I Jump: One Boy's Voice from the Silence of Autism* by Naoki Higashida<sup>59</sup> (translated into English by David Mitchell<sup>60</sup>). The impact from the book on the translator may to some extent explain the point.

He describes that the book is transformative in a way that reveals that such a person thinks just as another nonautistic member of the family would. It is the abnormal *behaviour* that the person cannot avoid because of a compelling force, and it is the reason why the person appears very different. Such behaviour sends out easily misunderstood signals. However, through the description in the book

<sup>58</sup> Cf. Zeki, S., *A Vision of the Brain*. Oxford: Blackwell (1993).

<sup>59</sup> Naoki Higashida, *Jiheisho no Bokuga Tobihaneru Riyu* (The Reason Why I, an Autism Patient, Jump Around). Kisaradu-shi, Japan: Esukoaru (Escor.co.jp) (2007).

<sup>60</sup> Mitchell, D., Introduction. In: *The Reason I Jump* [59], pp. 1–12, transl. K.A. Yoshida and D. Mitchell. London: Sceptre (2013).

Naoki Higashida succeeded in sending out signals leading to universal tie formation. By this understanding in depth, the tie within the translator's family was successfully formed.<sup>60</sup>

## **8. THE SHINGAKU MOVEMENT AND HOTOKUSHA RESTORATION IN THE EDO PERIOD OF JAPAN ARE EXAMPLES OF SELF-SUFFICIENT AND SUSTAINABLE EVOLUTION**

### **8.1 A self-sufficient and sustainable industrial system that lasted for a long interval**

In the Edo Period from 1600 till 1868, Japan was isolated from the rest of the world by the policy of the Tokugawa Government. During that period, rice farming was the main industry, and environmentally sustainable practices were developed.<sup>61</sup>

Under the feudalistic reign, the Shingaku Movement was initiated by Ishida Baigan and established the concept of public interest and the indispensable position of the merchant class in an agriculture-based society.<sup>62, 63</sup> The movement contributed to facilitating the exchange of goods throughout the country, surpassing the territories of clans. The movement further allowed accumulation of a huge amount of merchant capital. This capital percolated into society to evolve into the money-based economy.

Later in the Edo Period, Ninomiya Sontoku and his followers demonstrated the successful restoration of many farming villages.<sup>64</sup> The initiative is known as "Hotokusha", meaning a group to return the benefit endowed from heaven through ties among the people.

### **8.2 The Shingaku Movement**

Ishida Baigan (1685–1744), the son of a farmer near Kyoto, rose to the respected position of "Banto" (head clerk) of a large merchant house. However, he left the position to open a free school in Kyoto, teaching the ways of merchants with respect to the public interest and particularly how the master and clerks of a merchant house should behave. He justified merchants taking profit and raising capital via purchasing and selling of goods. He positioned the profit as equivalent to a samurai's stipends. This teaching was against the traditional Confucian authorities, who blamed profit-taking as greedy injustice. Baigan launched the concept of public interest. He preached that each class equally served the public: the samurai class for maintaining a peaceful society, farmers for producing food, the craftsmen fabricating tools; he positioned the merchant class as equally serving the public by delivering to those who need the goods. A lean lifestyle encompassing saving practices was recommended because it increased the stock of public assets.<sup>65</sup>

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<sup>61</sup> Eisuke Ishikawa, Inawaraga kuniwo sasaeta (Rice straws sustained the country). In: *Ooedo Risaikuru Jijou* (Recycling Situation in Edo in the Edo Period), pp. 48–70. Tokyo: Kodansha (1994).

<sup>62</sup> Kabushikigaisha Nakagawa Juken, Kameokato Ishida Baigan (Kameoka, the birthplace of Ishida Baigan) ([http://www.nakagawa-juken.com/page\\_baigan.html](http://www.nakagawa-juken.com/page_baigan.html)) (accessed 26 May 2016).

<sup>63</sup> Yui Tsunehiko, Shingakuno michi, nihonjin no moraru (The Shingaku way, the moral of Japanese). In: *Seiren no Keiei* (Clean and Virtuous Business Management), pp. 119–146. Tokyo: Nihon Keizai Shinbunsha (1993).

<sup>64</sup> Michio Mitooka, Zen shogaiwo yono tameni (Devoting one's whole life for the society). In: *Ninomiya Kinjiro no Issho* (Life of Kinjiro Ninomiya), pp. 503–523. Tokyo: Eiko Shuppansha (2002).

<sup>65</sup> Yui Tsunehiko, Kenyakuha sozono haha (Saving expenditure is the mother of creative ideas). In: *Seiren no Keiei* (Clean and Virtuous Business Management), pp. 50–59. Tokyo: Nihon Keizai Shinbunsha (1993).



This teaching attracted many people, not only from the merchant class but also from other classes. His disciples practised his teaching over a wide area of the country. When there was famine due to drought, the group of merchants collected donations and gave away rice to people in trouble, prolonging thousands of lives.<sup>66</sup>

Historically this movement encouraged accumulation of merchant capital and resulted in an enhancement of the influence of the merchant class. When the country faced the threat of colonization by Western countries, this accumulated capital provided the financial basis for groups working to demolish the feudal system. The movement led the country to the Meiji restoration, opening the gate to joining the modern world.

His teaching could well have been succeeded by “capitalism for the public interest” launched by George Hara,<sup>67</sup> and the “virtuous capitalism” proposed by Heita Kawakatsu.<sup>68</sup> In both, the necessity to prioritize on the public interest is emphasized.

### 8.2.1 *The teaching of Ishida Baigan in the Shingaku Movement*

The following summarizes the teaching:<sup>69</sup>

(a) The merchant plays an essential role in the society and serves the public by delivering goods to those who need them. The social system would not work without them.

(b) Merchants should innovate their business process, making the best use of available resources.

(c) Merchants should try to reduce internal costs and pass on any reduction as lower prices to customers.

(d) Since the market price is generally given, for merchants to take profit as the difference between price and cost, while taking the risk of loss when the cost is higher than the market price, can be justified.

(e) The master of a merchant house should behave as Confucius, Buddha, Mencius and other saints would, because all members of the house tend to follow his way. Baigan preached that undesirable practices of the master, such as lack of diligence, indulgence in sexual affairs, excess personal expenditure and immoral acts would surely result in the decline, bankruptcy and extinction of the house.

(f) When the master follows undesirable practices, the head clerk and key employees should discuss the matter and give advice to the master. If the master does not change his ways, they should ask the master to resign, with his living expenses compensated in order not to let him lose face.

<sup>66</sup> Hiroshi Eko, *Shokyoha kokorono togigusa* (All teachings are good for the development of mind and heart). In: *Ishida Baigan*, pp. 179–198. Kyoto: Seishin Keizai Kenkyusho (2005).

<sup>67</sup> George Hara, *Atarashii shihonshugino ruruwo tsukuru* (Developing new rules of capitalism). In: *21 Seikino Kokufuron* (A New Inquiry into the Nature and Causes of the Wealth of Nations), pp. 33–84. Tokyo: Heibonsha (2007).

<sup>68</sup> Heita Kawakatsu, *Fukoku yutokuno susume* (Recommendation for virtuous capitalism). In: *Fukoku Yutokuron*, pp. 11–34. Tokyo: Chuoukouron Shinsha (2000).

<sup>69</sup> Minoru Shibata, *Baigan kyogakuno konpon* (Fundamental teachings of Baigan). In: *Ishida Baigan*, pp. 87–107. Tokyo: Yoshikawa Kobunkan (1962).

(g) Merchants should practice the five virtues of Confucius: Jin, Gi, Rei, Chi and Shin; and respect the five key relationships of Mencius (to be explained in §8.2.2).

(h) Merchants should avoid waste, not only for the house but for the public as well.

(i) Merchants should work hard for stakeholders, namely (1) the employees and members of the house, (2) the customers and (3) the public.

### 8.2.2 *The background of Ishida Baigan's philosophy*

Baigan preached that all people owe their existence to Heaven, Earth and People (meaning ancestors), particularly to the goddess Amaterasu who created the nation and brought many gifts, such as rice farming, for people to live on. He apparently took this thought from Shinto, the traditional religion of the country.

He preached the guidance that people can acquire the status of “enlightenment” by three practices, meditation, listening to wisdom, and exchanging questions and answers. This style of teaching may have been taken from the practice in Zen Buddhism, in which enlightenment is preached as the ultimate target of such practices as meditation. Self-development of oneself is expected under the mentorship of higher-ranking priests.

The concept of Heaven and the practices he taught mainly came from Mencius, a Chinese philosopher who succeeded, and extended the teachings of, Confucius.<sup>70</sup> Ishida Baigan stressed the importance of the five *fundamental virtues* of Confucius<sup>71</sup> and the five *key relations* of Mencius<sup>72</sup> to be highly respected and practiced. Those teachings had been addressed to the ruling class, including bureaucrats, in China and Japan. Baigan preached them to the merchant class, which had been looked down upon because of profit-taking. He presumably thought that the fundamental virtues are necessary to sustain a merchant family for many generations; the continuation and prosperity of a family were great concerns in feudal society. He would also have thought that a virtuous way of living and managing business was a necessary condition for the merchant class to exist and that it was indispensable in society to serve the public interest; and that key relations are important for the merchant class to be appropriately positioned in feudal society. The key relations would lead to the formation of strong ties both vertically and horizontally, and back in time (historical). Ties with coworkers, residents in the same area, ancestors, descendants, the next generation (infants), existing family, master, friends; all these can contribute to the sustainability of economic entities, Baigan preached.

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<sup>70</sup> Hiroshi Eko, *Ishida Baigan*, pp. 1–6. Kyoto: Seishin Keizai Kenkyusho (2005).

<sup>71</sup> The five fundamental virtues of Confucius are:

- (a) Jin: Benevolence to others in general;
- (b) Gi: Justice, particularly with reference to relationships;
- (c) Rei: Proper behaviour, particularly towards the upper levels in any social hierarchy and elders;
- (d) Chi: Wisdom;
- (e) Shin: Trust.

<sup>72</sup> The five key relationships (to be respected and emphasized) of Mencius are:

- (a) Parents and child: Nurture for the former, filial piety for the latter;
- (b) King and vassal: Leadership for the former, loyalty for the latter;
- (c) Husband and wife: Affection for each other;
- (d) Senior and junior: Guidance for the former, respect for the latter;
- (e) Friend and friend: Trust and honesty.

The broad ties formed by the merchant class served the evolutionary development of society even under feudal constraints.

### 8.3 The Hotokusha Restoration initiated by Ninomiya Sontoku to activate farming villages

#### 8.3.1 *The history of the Hotokusha Restoration movement*

Ninomiya Sontoku, the teenage son of a farmer in Odawara, worked hard to restore his family land after serious flood damage. Through the work he learned the engineering of weirs and water channels. These skills endowed him with strength when he led the restoration of farming villages later. He also learned from many books and developed his own philosophy concerning one's perception of the world. The long peace and availability of books produced by woodblock printing encouraged even farmers to learn. He respected the traditional religions, Confucianism, Buddhism and Shinto, as forming the core of spiritual ties in villages.<sup>73</sup>

He guided the restoration of many villages and was invited by the feudal lord of the Odawara clan to restore its sister clan of Sakuramachi.<sup>74</sup> Many other successes followed, including the big Sohma clan.<sup>75</sup> He had some unsuccessful cases, due to opposition from the samurai class.<sup>76</sup> He and his disciples formed Hotokusha (literally meaning “grace-returning company”) groups, and initiated a movement to restore many villages facing economic and political difficulties due to high rates of taxation and poor working disciplines.

The Hotokusha movement declined in the Meiji era, due to the Industrial Revolution and the associated capitalist system. However, there still remain a few germane organizations and its principles are nowadays revisited by many who seek better business management and restructuring. The author believes that the bottom-up approach would be valuable for the restoration of local economies that declined during the expansion of the global economy and financial influence.

#### 8.3.2 *Practices of the Hotokusha Restoration*

The Hotokusha Restoration was composed of the following set of practices, emphasizing financial and engineering activities well organized temporally:<sup>74</sup>

(a) The establishment of leadership: The feudal lord should launch a firm determination for restoration of the whole clan as *the* top-down decision at the highest level of the hierarchy.

(b) Awareness: A sense of crisis shared among people, particularly farmers, is the condition to initiate restoration.

(c) Near-term budget-setting: The near-term budget of the clan should first be worked out based on income over the last ten years. This consideration forced reduction of the clan's expenditure, including samurai stipends.

<sup>73</sup> Bellah, R., The peasantry and Hotoku movement. In: *Tokugawa Religion*, pp. 126–131. New York: The Free Press (1957).

<sup>74</sup> Michio Mitooka, Sakuramachiryono fukkou jigyou (The restoration of the Sakuramachi clan). In: *Ninomiya Kinjiro no Issho* (Life of Kinjiro Ninomiya), pp. 95–122. Shinagawa-ku: Eiko Shuppansha (2002).

<sup>75</sup> Kokei Tomita, Restoring the Soma district. In: *Hotokuki*, transl. Tadasu Yoshimoto as *A Peasant Sage of Japan*, pp. 34–36. Memphis, USA: General Books (2012).

<sup>76</sup> Kokei Tomita, Helping the people of Odawara. In: *Hotokuki*, transl. Tadasu Yoshimoto as *A Peasant Sage of Japan*, p. 33. Memphis, USA: General Books (2012).

(d) Long-term visionary plan: A long-term sustainable plan (usually for ten years) was made, incorporating the target based on astute characterization of the clan and its people. The economic scale targeted was generally smaller than the previous budget, but much larger than the near-term target.

(e) Small initial steps: The scale of activity at the start was always small, constituting a target relatively easy to achieve. In the first step, people could learn the methods and accumulate assets for the next step. Then, steady expansion followed until the activities penetrated into the whole clan.

(f) Internal financing until harvest: The Hotokusha Restoration always offered reasonable financial schemes, with or without interest, not given away, until harvest time when the farmers could repay their borrowings. Effective financing was a part of the strength of Hotokusha. Hotokusha itself gradually accumulated a substantial volume of assets.

(g) Financing from many sources: Guaranteed by the feudal clans.

(h) Conversion of financial sources to those with lower interest rates.

(i) Urgent repair of ruined houses: Repair of farmers' houses was given priority so that farmers and their families could return to work

(j) Urgent repair of shrines: Shinto shrines were similarly given priority for repair, in order to demonstrate respect and gratitude to ancestors. Shrines were the centre of people's ties, where festivals were celebrated upon occasions of religious and seasonal importance.

(k) Engineering of weirs and water channels: Ninomiya Sontoku had acquired engineering knowledge and practical skills to recover from flood damage and prevent it in the future.

(l) Lean life, hard work and saving: Farmers were encouraged to work hard, live a lean life and save half of their excess income (mostly from rice crops) for future difficulties and public welfare (the fact that there were no deaths in villages restored by Hotokusha during the frequent famines made the movement famous, resulting in requests for guidance from many clans and villages.)

## **9. THE TOYOTA LEAN PRODUCTION SYSTEM AS A BOTTOM-UP APPROACH**

### **9.1 Revolutionary manufacturing to grant autonomy to the production floor**

Taiichi Ohno of Toyota aimed to compete against big overseas automobile manufacturers equipped with huge production facilities and employing the Taylor method for. His idea was *generating profit internally* under given market prices by revolutionary ways of production and logistics. His principles are:<sup>77</sup>

(a) Pull production instead of "Push", meaning manufacturing the amount requested from the next stage, down to the customer's latest demand, rather than the previously customary way of planned production;

(b) Tied production and logistics by the *Kanban system*, where the supply chain is controlled by the use of tools called "Kanban", a sign board or card indicating what and when to produce, passed on from downstream to upstream along the production line and the supply chain to signal

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<sup>77</sup> Japan Management Association (ed.), transl. D.J. Lu. The source of profit is in the manufacturing system. In: *Kanban, Just in Time at Toyota*, pp. 24–53. Cambridge, Mass.: Productivity Press (1986).

whether the next stage requires supply. Kanban was further applied at separate work sites, and to separate component manufacturers. Many of these outside suppliers constituted the “Keiretsu”—a group of companies with mutual business relationships and shareholdings. Toyota offered them guidance for improvement based on its production system, further strengthening the ties among the Keiretsu;

(c) Synchronized work with production flow lines stopping at times of abnormality or delay at any point;

(d) Maximizing efficiency by identifying and removing *seven wastes*:

- (i) Delay, waiting and time spent in a queue with no value being added;
- (ii) Producing more than is needed;
- (iii) Undertaking non-value-adding activity;
- (iv) Unnecessary transportation;
- (v) Unnecessary movement or motion;
- (vi) Unnecessary inventories;
- (vii) Production of defective goods.

These revolutionary practices pushed Toyota to become the most profitable manufacturer with high quality products. Taking inspiration from the Toyota production system, many management concepts were launched around the world: *Lean Manufacturing* by John Craftick, *Reengineering of Business Processes* by Michael Hammer, *Just in Time Management*<sup>17</sup> and *Management by Trust* by Francis Fukuyama<sup>15</sup> are a few examples.

## 9.2 Sony adopts the Toyota system

Hitoshi Yamada, one of Ohno’s disciples, and the founder of the Productivity Education Centre (PEC)<sup>78</sup> was invited to guide Sony’s factories according to the Toyota production system. He also visited the semiconductor fabs for which the author was responsible, following which changes were made. Through efforts lasting many days the mindset of managers and workers changed dramatically:<sup>79, 80</sup>

(a) The belt conveyer system composed of many divided works based on the Taylor method was abandoned. Instead, the same sequence of assembling many components on desk tops or around a single worker was assigned to multiple workers. In this way, in-work stocks were eliminated and workers found opportunities for self-improvement and learning from other workers.

(b) Machines both smaller and slower were recommended because they required less investment. Concomitantly, workers were able to understand the process, and acquired a certain autonomy to respond to the market and repair and improve the equipment on their own.

(c) Non-value-adding processes were eliminated, such as internal product movement, inspection (unnecessary if the in-process works have a vanishingly small probability of being defective), etc.

<sup>78</sup> Hitoshi Yamada, *Kaizen-Damashiiwo Motomete* (Exploration of “Kaizen” spirit), pp. 9–12. Tokyo: Nikkan Kogyo Shinbunsha (1998).

<sup>79</sup> Management Innovation Team, Sony Oita Corporation, Reducing the lead time for IC assembly to ¼. *Kojo Kanri* (Management of Factories) **42** (1996) 4–17.

<sup>80</sup> NEC Kagoshima Corporation, Seisan kakushinde hitoga yomigaeru (Human vitalization through production innovation). *Kojo Kanri* (Management of Factories) **42** (1996) 26–47.

A remarkable change was observed on the production floor regarding the worker's attitude. Each worker now emerged as an individual: active, teamwork-oriented, cooperative, mutually stimulating and learning from each other. Thus was developed floor leadership, or the organized bottom-up approach, all over the factory. The semiconductor and LCD fabrication processes, particularly assembly and testing, were improved dramatically.<sup>81</sup>

However, wafer processing fabs consisting of sophisticated equipment<sup>51</sup> requiring huge investment was left for future challenges. Although enthusiastic efforts were made in wafer fabs, resulting in substantial improvement in lead time, the challenge was not fully completed within the contemporaneous constraints. It was left to following challengers including Sony Toyota LCD (STLCD), a carve-out joint venture (JV), later consolidated to Japan Display.

### **9.3 Sony and Toyota work together for a high resolution LCD**

Although Sony had the Trinitron tube as the key display component, small displays with high resolution were strategically important for portable products such as video cameras, digital cameras and cellular phones. The low-temperature poly-silicon (polycrystalline silicon, p-Si) technology had been researched at the Sony Research Centre and transferred to the semiconductor business unit. STLCD was founded in 1997 as to manufacture LCDs based on this technology. The joint investment was 50 milliard yen, equally shared by the two companies.<sup>82</sup> As president of the semiconductor business of Sony, the author was involved in this JV; where the hidden agenda was to challenge and apply the Toyota concept to the wafer fabrication of semiconductors and LCDs.

In 2009, all STLCD stock was acquired by Sony, and in 2011 Sony, INCJ (Industry Network Corporation of Japan, a fund supported by the government and major industry players), Toshiba, Hitachi and later Panasonic agreed on the consolidation of high-resolution small-sized LCD businesses with ¥2,000 oku ( $\$2 \times 10^9$ ) funding from INCJ, inviting Shuichi Otsuka of STLCD as CEO.<sup>83</sup> Thus, in 2013, Japan Display started as a JV of these five entities and STLCD itself became part of the JV. In 2014, the company went public and collected ¥1,600 oku ( $\$1.6 \times 10^9$ ) on the Tokyo stock exchange.<sup>84</sup> As a result, the author expects that the Toyota bottom-up lean manufacturing concept will be incorporated into the most actual top-down approach in wafer processing to produce nanostructured LCDs and semiconductors.

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<sup>81</sup> Management Innovation Team, Sony Oita Corporation, Reducing the lead time for IC assembly to ¼. *Kojo Kanri* (Management of Factories) **42** (1996) 18–25.

<sup>82</sup> ST Liquid Crystal Display Corp. The fusion of contrasting DNA—when true value of this approach is demonstrated, total shipments of low temperature polycrystalline silicon TFT LCDs has broken the 100 million mark. *CX-NEWS* **39** (2005-2) ([http://www.sony.net/Products/SC-HP/cx\\_news/vol39/sideview.html](http://www.sony.net/Products/SC-HP/cx_news/vol39/sideview.html)) (accessed 1 March 2014).

<sup>83</sup> Sony Corporation. INCJ, Hitachi, Sony and Toshiba sign definitive agreements regarding integration of small- and medium-sized display businesses (<http://www.sony.net/SonyInfo/News/Press/201111/11-1115E/>, 15 November 2011) (accessed 15 January 2014).

<sup>84</sup> Japan Display Inc., Notice regarding resolution of board of directors relating to issuance of shares to be offered and secondary offering of shares ([http://www.j-display.com/english/news/2014/20140214\\_2.html](http://www.j-display.com/english/news/2014/20140214_2.html), 14 February 2014) (accessed 12 March 2014).

**10. THE SONY WAY INITIATED BY MASARU IBUKA, A BOTTOM–UP APPROACH UNDER STRONG ASPIRATION**

Masaru Ibuka, founder of Sony, rolled out a new set of business philosophies to unleash the creativity of people through the bottom–up approach. For this purpose he strove to endow the company with a free and exciting working environment. His leadership inspired many talents, with whom he made Sony into a world-class organization.<sup>85</sup>

**10.1 Sony’s founding prospectus**

The Sony Way is best described in the founding prospectus Ibuka drafted in 1946 when the company started, in which he clearly stated the ideas that he had nurtured for many years. The Sony Way was launched as an antithesis to the then generally accepted style of top–down business management. The prospectus was so enlightening to those who shared business life at Sony that it poured strength and energy into them, including the author. It sharply contrasted with the Taylor method of measuring workers’ contributions mechanically. The introductory statement can be translated as follows:<sup>18</sup>

... Thus I began to conceive of ways for these motivated individuals to unite in devotion, to embrace a firm cooperative spirit and unleash their technological capacities without any reserve. If this could be realized, the organization would become like a melting pot of enthusiasm, and accomplish incredible things, even if the facility is small like a garage and human resources are limited.

The statement continued with the purpose of incorporation:<sup>18</sup>

(a) To build an ideal factory where engineers with sincere motivation can unleash their internal strength and demonstrate their skills and talents to the utmost in a free, open-minded and enjoyable environment;

(b) To elevate the nation’s culture through dynamic technological and manufacturing activities;

(c) To swiftly apply highly advanced technologies to common households;

(d) To promote the education of science among the general public.

He further stated the management policies as:<sup>18</sup>

(a) We shall pursue fair profit-seeking, constantly emphasize activities of real substance and not gratuitously seek expansion of their scale;

(b) We shall maintain our business operations comparatively small, advance technologically and grow in areas where large enterprises would not enter for the sake of their scale;

(c) We shall be as selective as possible in our products and will welcome technological difficulties. We shall focus on highly challenging technical products that have great usefulness in society, regardless of the quantity involved. We shall avoid any formal demarcation between electronics and mechanics, and create unique products others can never follow by integrating the two fields;

(d) We shall fully utilize our firm’s unique characteristics;

(e) We shall guide and foster subcontracting factories in ways that will help them to grow and become independent, and we shall strive to expand and strengthen mutual cooperation with such factories;

<sup>85</sup> Seiichi Watanabe and Shingo Tamura, Looking ahead for a shift to a human-centric paradigm through creativity, the aspiration of Masaru Ibuka, founder of Sony. *Journal of Creativity and Human Development*, to be published.

(f) We shall carefully select members, and thus our firm will be comprised of a limited number of employees firmly tied with respect and human dignity. We shall avoid having a formal hierarchical structure, placing emphasis on special abilities, devotion and active attitudes, so that each individual can fully demonstrate skills and talents;

(g) We shall distribute the company's surplus earnings to all employees in an appropriate manner, and we shall assist them in a practical manner to secure a stable living. In return, all employees shall exert their utmost effort into their job.

## **10.2 The Sony Way inherited by management and employees as the legacy of Masaru Ibuka**

Masaru Ibuka's words well express the core principles of the Sony Way:<sup>85</sup>

*10.2.1 Common ways of thinking are unnecessary. We should hire those who prefer unusual ideas and devote themselves to making things*

The three eccentrics who made a great contribution to the company and to society are well known examples of such uncommon personalities:

(a) Toshitada Doi, who promoted compact disk systems in an alliance with Philips, and later initiated Aibo robots.

(b) Yoshitaka Ukita, who came up with the "Diskman" portable digital audio, and drove the market transformation to digital audio from analogue gramophone disks. He promoted the LIBRie electronic book much earlier than anyone else.

(c) Ken Kutaragi, who applied digital video technology to video games. His team was carved-out to form Sony Computer Entertainment within Sony Music Entertainment and successfully established the PlayStation platform, which later brought Sony more profit than its traditional electronic products.<sup>86</sup>

*10.2.2 You should not expect to be assigned challenges by the company, but should identify them by yourself*

Quite a few engineers who had new ideas developed prototypes without reporting to their bosses. The top-selling "Walkman II" and the "Video Movie" were born this way. It is noteworthy that it was Ibuka who showed surprise and curiosity when these secret prototypes were revealed. He revealed his excitement by asking many questions. Hence, many engineers worked hard on this kind of bottom-up approach in the hope of surprising him.

*10.2.3 Consider your job at Sony as your life*

Ibuka loved golf and encouraged employees to enjoy their leisure time. At the same time it was his style to visit factory floors, asking many questions and offering suggestions. So, many engineers brought sleeping bags to the company at critical times.

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<sup>86</sup> Reiji Asakura, *Kutaragi Ken no Puresute Kakumei*, pp. 59–62. Tokyo: Waku Kabushikigaisha (2003). English version: Reiji Asakura, *Revolutionaries at Sony: The Making of the Sony Playstation and the Visionaries Who Conquered the World of Video Games*. New York: McGraw Hill (2000).



### 10.2.4 *The value of creation is invariant*

Ibuka's criterion of creativity was very strict, with emphasis on originality and real-life impact. By asking questions, he tried to discover the hidden value of creation. He often referred to this statement, meaning that once something is created, the value is invariant regardless of the success or failure of commercialization. When a new research facility was built and a monument with this statement was revealed, he traveled a long distance in his wheelchair for the ceremony and the open house that followed. It impressed everybody there how enthusiastically he listened to the explanations of researchers and asked many questions. He seemed as if he was still trying to find creations with invariant value. The Research Centre was founded by him when Sony was a small company, which sent a strong message of encouragement to researchers.

### 10.3 Unique products that appealed because of their small size

The product that made Sony a global brand was the transistor radio (and transistorized audio and video products), all taking advantage of the small size and small power consumption, and operated by batteries in many cases.<sup>85</sup> At that time, the products of established giants were designed like furniture to sit in the living room, and it was not easy to convince American people, rich and possessing an abundance of living space and resources, that the small size and small power consumption were valuable. In addition, it was a very high-risk challenge to make transistors from scratch while achieving satisfactory high-frequency performance as required for radio bands for a start-up with annual sales of only a couple of million dollars. Nevertheless, the subsequent history tells us that the highly motivated scientists and engineers, limited in numbers but with their creativity unleashed, allowed the company to launch unique products that appealed greatly to people all over the world.

### 10.4 PlayStation and the challenge for platform service business models

#### 10.4.1 *The success of PlayStation as a platform service business and a "carve-out" model*

The PlayStation could have marked an epoch for the company to pursue platform-based service business models, taking advantage of digital technologies and the Internet, benefiting from the "carve-out" scheme. As mentioned, the application of digital video technology to electronic games was conceived by Kutaragi at the Sony central research laboratory. However, almost all executives at Sony were against introducing this new software-intensive business, as the business model was quite different from that for the hardware the company had traditionally pursued.<sup>86, 87</sup> Therefore the group was transferred (or, using the present author's terminology, "carved out") by Norio Ohga, then CEO, to Sony Music Entertainment (SME), where music content management was the key focus.<sup>88, 89</sup> The business was thus successfully developed in a

<sup>87</sup> Norio Ohga, *SONY no Senritsu*, p.232. Tokyo: Nihon Keizai Shinbunsha (2003), English version: Norio Ohga, *Doing it our Way*. Tokyo: International House of Japan (2008).

<sup>88</sup> Reiji Asakura, *Kutaragi Ken no Puresute Kakumei*, p. 69. Tokyo: Waku Kabushikigaisha (2003), English version: Reiji Asakura, *Revolutionaries at Sony: The Making of the Sony Playstation and the Visionaries Who Conquered the World of Video Games*. New York: McGraw Hill (2000).

<sup>89</sup> Norio Ohga, *SONY no Senritsu*, pp. 229–232, 235–236. Tokyo: Nihon Keizai Shinbunsha (2003), English version: Norio Ohga, *Doing it our Way*. Tokyo: International House of Japan (2008).

completely different business culture. At a later epoch, this business earned more profit than Sony Electronics; hence after a few years Sony judged that it should be one of its core businesses. They brought it back by way of equivalent stock exchange<sup>90</sup> and SME stockholders enjoyed a huge capital gain. The consolidation was done with the expectation that the business would open a major gateway to the future for Sony: the Internet.<sup>91</sup>

The characteristic of a platform business is explained by the necessity to sell sufficient number of game consoles to customers to establish a platform. Then content creators become motivated to design new games on the platform. Generally 3 million to 5 million consoles must be sold in a short time at a price acceptable to gamers. Since the new console incorporates the most advanced LSI graphics chips, pricing is usually below manufacturing costs, generating a deficit of \$300 to \$500 million if the loss is \$100 per unit. In addition, game development tools must be delivered to content creators prior to game content development, meaning a further huge amount of prior investment.

However, once the platform is well established, the platform can effectively sustain efforts of game creators and attract gamers, allowing for stable profit. The business model differs fundamentally from that for traditional electronics manufacturing especially in the scale of the required initial investment and the associated necessity of risk taking.

#### *10.4.2 Unsuccessful platform challenges*

There were quite a few cases in which Sony did not dare to challenge platform-oriented businesses. History tells us that the company leaders, brought up with productcentric successes, were not able to adapt to the Internet-driven platform concepts. This may possibly explain the poor performance of the company today.

##### *10.4.2.1 Felica, a secure contactless card*

Felica is Sony's proprietary card with noncontact communication capability, incorporating strong encryption and security. It was developed by a team of engineers led by Susumu Kusakabe. It was first used in Hong Kong's metropolitan railway (MTR) as the "Octopus Card" to replace tickets.<sup>92</sup> Although Kusakabe's team proposed to deploy the card worldwide and establish a global platform, the proposal did not win the top management approval. The business was scaled down to card manufacturing and licensing. Kusakabe left Sony in disappointment, and Sony lost an opportunity to become an influential "platformer". It was Akira Shiihashi of Japan Railways (JR) who later took the risk to establish the card as an all-Japan platform.<sup>93</sup> It not only replaced tickets but now works as a convenient credit card for daily

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<sup>90</sup> Hori, S., *Nihon Kigyō Shinka no Joken* (Conditions of Japanese companies for evolution), pp. 97–98. Tokyo: Toyokeizai-Shinposha (2002).

<sup>91</sup> Gershon, R.A., The Sony Corporation: A case study in transnational media management. *Intl J. Media Management* 4 (2002) 105–117.

<sup>92</sup> Sony Corporation, IC card tickets throughout Asia Pacific (<http://www.sony.net/Products/felica/casestudy/index.html>) (accessed 23 May 2016).

<sup>93</sup> Akio Shiihashi, Penguin ga sora wo tonda hi (The day the penguin flew the sky). *Kotsushinbunsha* (August 2013), p. 197.

shopping. At the planning stage, investment as large as \$400 million was approved for this broad usage scope.

#### 10.4.2.2 Electronic books

Yoshitaka Ukita successfully launched LIBRie, Sony's electronic book, three years prior to Amazon's launch of a rival product. He made huge efforts to bring Japanese publishers to the platform. However, the rival Amazon focused on gaining customer numbers and successfully established their platform, driving out all competitors. Sony management had prioritized the features of the product rather than platform establishment, despite the previous success with PlayStation.

### 11. "CARVE-OUT" START-UPS TO ENHANCE BUSINESS CHALLENGES FOR SUSTAINABILITY

#### 11.1 Conception

At JATES, an industrial association composed of the CTOs of about a hundred major companies, the strong concern of members (including the author) representing Sony was the increasing difficulty of commercializing research outputs, particularly disruptive innovations (described as the "innovator's dilemma"<sup>94</sup>). For the author, the low-temperature poly-silicon (LTPS) LCD was such a case.

Research work is basically a bottom-up process. It depends heavily on the creativity of researchers. Even if researchers are themselves motivated regarding the achievement of sustainability, transfer of such technologies to existing business units is not easy.

A project was organized to search for ways to bring such research outputs to commercialization.<sup>95</sup> In the proposed scheme, the technology together with key personnel is "carved-out" from established companies or research institutes to create a start-up, which has the freedom for disruptive innovation, with funding, and hands-on incubation promoted by external experts.

#### 11.2 Implementation

Since the proposal was not able to move JATES members, the author and his friends founded TechGate Investment and raised a fund of about \$40 million, "Technology Carve-out Limited Liability Investment Partnership", with the company as general partner (GP), inviting major financial institutions as limited liability partners (LPs).<sup>35</sup>

#### 11.3 Expectation

The fund invested in ten start-ups and incubation efforts were made for ten years. Although performance was not successful with respect to return on investment, most of the supported start-ups are still working hard to realize disruptive innovation. The author met many scientists

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<sup>94</sup> Christensen, C.M., *The Innovator's Dilemma*, pp. 258–261. New York: Harper Business (2000).

<sup>95</sup> TechGate Investment, Inc. and Japan Techno-Economics Society, *Kaabu-auto-gata Jigyou Souzou ni Kansuru Chousakenkyu* (Research on Business Creation on the Carve-Out Scheme). Tokyo: Japan Techno-Economics Society (2008).

and engineers motivated to utilize technologies for advancing sustainability. Via this scheme, they were able to acquire freedom and create ties with many kinds of talents in the business and marketing domains. Thus, they had the opportunity to pursue their dreams.

Although the present author must admit that the challenge has not been able to fully demonstrate the advantage of the scheme, it is expected that it will be continued and encourage many scientists and engineers motivated to transform industry and society.<sup>96</sup>

## **12. TO CHANGE THE PASSIVE SOCIAL MODEL OF HEALTH AND MEDICAL CARE TO ACTIVE SELF-IMPROVEMENT**

The Sensor Network Study Project has been promoted for the last eight years.<sup>98</sup> A review of research on healthcare and medication indicated that continuous sensing of health parameters would yield valuable information, which could motivate individuals to actions for self-improvement for health and disease prevention.<sup>97-99</sup>

In advanced countries, where systems of social welfare are well established, it is common practice to visit the medical doctor after a disease is contracted. Patients rely on prescribed medicines and, if necessary, surgery. Health insurance covers the expense. Consequently, the attitude of the patient becomes quite passive. Health insurance coverage discourages self-improvement activities, such as combating stress, physical exercise, adopting a sensible diet and other preventive measures. In the case of treatment of teeth, cavity filling is covered by health insurance in Japan and, hence, the immediate cost to the patient is much less than preventive care not thus covered. However, the social cost is much higher for the former, and patients can use their teeth for their entire life if well cared for, resulting in a much better quality of life, illustrating the need to change the present passive social model, heavily dependent on medicines and surgery after diseases are contracted, to active health promotion and disease prevention through self-improvement activities. Results from the Project indicate that a sensor network service could change the situation. Accordingly, Health Improvement Net Service LLC (HINETs), a start-up, has been recently founded by the author and his colleagues for the purpose of realizing this social innovation.<sup>34</sup> Its service has been designed to utilize a set of devices to sense health parameters. The data are then sent to a central server and, in return, displayed as tables and graphs. A monthly review of the sensed data is delivered to each member

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<sup>96</sup> A summary of fund activity and lessons learned will be reported at PICMET 2016: Japan Techno-Economics Society, *Sensor Network Study Project* ([www.jates.or.jp/management\\_study/sensor\\_network/plenary\\_session\\_sen.html](http://www.jates.or.jp/management_study/sensor_network/plenary_session_sen.html)) (accessed 7 Jan. 7 2016).

<sup>97</sup> Shintai Undo Kagaku Kenkyushitsu, University of Tokyo (Laboratory for Physical Movement Science Research, University of Tokyo), *Shintai Undo Kenkokagaku Jisshu Hokokusho 2006* (Report on 2006 Training and Study Course on Physical Movement and Health Science), p. 25. Tokyo: Shintai Undo Kagaku Kenkyushitsu, University of Tokyo (March 2007).

<sup>98</sup> Shintai Undo Kagaku Kenkyushitsu (Laboratory for Physical Movement Science Research, University of Tokyo), *Shintai Undo Kenkokagaku Jisshu Hokokusho 2006* (Report on 2006 Training and Study Course on Physical Movement and Health Science), p. 79. Tokyo: Shintai Undo Kagaku Kenkyushitsu, University of Tokyo (March 2007).

<sup>99</sup> Shintai Undo Kagaku Kenkyushitsu (Laboratory for Physical Movement Science Research, University of Tokyo), *Shintai ni Taisuru Ishiki Chosa 2006* (Research on Consciousness on Human Body), p.103. Tokyo: Shintai Undo Kagaku Kenkyushitsu, University of Tokyo (March 2007).

with comments and recommendations from health scientists and medical specialists. The breakthrough event for this service will be identification of key motivators for each individual and utilization of the motivators to trigger sustainable activities for preventive self-care.

The main target of HINETs at present is arterial stiffness, including cardiovascular health. A salt intake meter, a blood pressure meter and an activity meter combined with periodical arterial stiffness measurement are deployed. Recent surveys show that arterial stiffness is strongly correlated with the outcome of dementia, a huge problem in our aging societies. Based on its findings from the accumulated evidence, the company aims, as a next step, to develop an algorithm to compute the economic impact as well as the health benefits in each individual's life.

*The tie* is the hidden critical driver of such activities. The tie for each individual, with his or her physical and mental self, is not usually recognized; *sensing helps one to understand one's self*. Ties with other individuals also working on self-improvement become informative and encouraging through comparison and, sometimes, competition. Thus, tie creation in this field is expected to contribute to achieving the paradigm shift to sustainability of the welfare system.

### 13. SUMMARY AND EXPECTATIONS

At first sight, world history looks as though it is the result of Darwinian natural selection having prevailed in its evolution, allowing superiors to prosper and inferiors to diminish through struggles. It also looks as if the Darwinian paradigm has been accepted as the way to realize a better society.

However, the world now faces challenges from the risks to sustainability of human society as well as the natural environment, including the diversity of living creatures. Those involved in the sciences, including physical, human and social branches, as well as in activities like business, politics and medicine, face the imperative of a paradigm shift to *sustainable* evolution.

Looking back at the history of Japan, and taking insight from nanotechnology,<sup>100, 101</sup> it is proposed that the world now faces a crisis of sustainability, for human society as well as our natural environment, and that the crisis has been caused by human expansionism based on a narrowly interpreted Darwinian natural selection. The self-organization observed in nanostructures is a metaphor for the natural, bottom-up processes forming organized structures at higher levels in a hierarchical arrangement as a guiding principle to interpret history. The author then defines the *tie* as the driving force of the bottom-up self-organizing processes in human society.

Three historical processes have been used as examples: the education of young children as understood by Maria Montessori, Shinichi Suzuki and Masaru Ibuka; the social movements in the Edo Period of Japan, namely the Shingaku Movement and the Hotokusha Restoration; and the Toyota Production System in modern history. The author has seen the deep tie as the driving force of a bottom-up self-organizational impulse in each of these historic processes.

The neutral theory of molecular evolution has been referred to and contrasted with Darwinian natural selection; the former is a bottom-up process and the latter a top-down one. The point is that narrowly interpreted Darwinian natural selection does not represent the whole of evolution in nature; the bottom-up process plays an essential role.

<sup>100</sup> Ramsden, J.J., What is nanotechnology? *Nanotechnol. Perceptions* **1** (2005) 3–17.

<sup>101</sup> Baumberg, J.J., Cronin, L., Gee, M., Kearnes, M.B. Macnaghten, P., Makatsoris, H., Ramsden, J.J., O'Reilly, R. and Webb, M., Where is nano taking us? *Nanotechnol. Perceptions* **3** (2007) 3–14.

The Sony Way launched by Ibuka, which pushed Sony to become a world class company, has been expounded. The management philosophy to let each engineer demonstrate his or her capability to the utmost in a free and exciting environment resulted in many innovative products. This bottom–up approach, with firm ties among management and employees, was the key to success.

A fund-raising and management effort to encourage scientists and engineers to create start-ups aiming for the realization of sustainable society is described. A new business entity aiming to change the present passive social model for healthcare and medication is also described. Both exemplify the bottom–up process.

Schumpeter perceived the nature of capitalism as sustained by unceasing evolutionary processes enhanced by entrepreneurship. This view suggests that the world needs to come back to the starting point of capitalism to resume such bottom–up processes and redirect innovation efforts towards sustainability.

World history is reviewed from the standpoint of evolution towards sustainability. The hope of the author is expressed as the strengthening of ties among different cultures to enhance bottom–up activities and promote evolutionary processes heading for sustainability through a paradigm shift.

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