

The Impact of Social Fabrication on the new stage of Information Society using InfoSocionomics Framework

Izumi Aizu, Shumpei Kumon

Izumi Aizu, Institute of Infosocionomics, Tama University

Shumpei Kumon, Institute of InfoSocionomics, Tama University

Abstract

Digital fabrication machines such as laser cutters, milling machines and 3D printers are now receiving phenomenal attention. This paper positions the Social Fabrication movement within the theoretical framework of the Information Society using the InfoSocionomics framework developed by Shumpei Kumon. The authors argue that the 'social' dimension of digital technology has become the key driving factor in recent years and that the movement is better characterized as 'Social Fabrication' rather than digital or personal fabrication. The paper examines the parallel development of the Third Industrial Revolution and the First Information Revolution, analyzing three phases of industrialization and their relationship to the emergence of a new stage of Information Society. Through theoretical analysis, the authors foresee that the combination of these two revolutions will form a new type of society in which people produce and share goods among themselves, beyond conventional business systems.

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Izumi Aizu

Senior Research Fellow and Professor, Institute of Infosocionomics, Tama University
Executive Director, Institute for HyperNetwork Society

Shumpei Kumon

Director and Professor, Institute of Infosocionomics, Tama University
Chairman of the Board of Trustees, Institute for HyperNetwork Society

1. Introduction

Digital fabrication machines such as laser cutter, milling machine and 3D printer are now receiving phenomenal attentions. The digital fabrication machine industry may become the leading industry of the times that enables the rise of the “Third Industrial Revolution”.

We found that “social” dimension of the use of the digital technology, or “social technology” in short, has become the key driving factor in the recent years and leading the First Information Revolution. In this regard, we consider it is quite relevant to call the new movement as the Social Fabrication movement rather than digital or personal fabrication movement.

In this paper, we positioned the Social Fabrication movement within the theoretical framework of the Information Society. We foresee that the combination of the Third Industrial Revolution and the First Information Revolution will eventually form a new type of society as a whole. With the proliferation of the social fabrication in particular, people will start producing goods and products among themselves, rather than buying from the supermarkets or online malls. More importantly, people will share the process

of making things much more than today, as well as sharing the products themselves.

It may sound unrealistic today. But just like what happened around the emergence and growth of the Internet over the last 20+ years, this Social Fabrication movement will make a significant impact on the way we live, learn, work and play. It will present the new stage of the Information Society.

It may be felt too early to precisely describe the coming state of the Information Society driven by the Social Fabrication movement. The same challenge was given to the emerging research works some 20 years ago when a number of social science researchers tried to grasp the growing social phenomena around the Internet or computer networks at large. Whenever a rapid social change or growth happens, the amount of empirical evidences is inherently limited, making it very difficult or almost impossible to produce objective research that matches the conventional methodology.

However, theoretical analysis using the *InfoSocinomics* frameworks described below will help grasp the impact of these new social fabrication movement on the coming society, the new stage of the Information Society.

2. The formation of Information Society

In order to understand the formation process of the Information Society, let us first briefly describe our conceptual framework for capturing general social changes as shown in Fig. 1 and Fig. 2 developed by Shumpei Kumon as the basis of the study if InfoSocinomis [Kumon 2001].

Kumon argued that we can recognize, at least empirically, the following three universal social laws penetrating all layers of social objects. The first law may be called a diachronic law. It is assumed that any social object or “species” in any layer evolves through several phases, starting from the “formation” phase, shifting to the “emergence,” “breakthrough,” and “maturation” phases, and finally reaching the “establishment” phase. This process of evolution may be conveniently schematized as a sigmoid or an s-shaped wave as shown in Figure 1. From this point of view, the evolutionary processes of various social objects taken as a whole could be imagined as a fractal of numerous sigmoids.

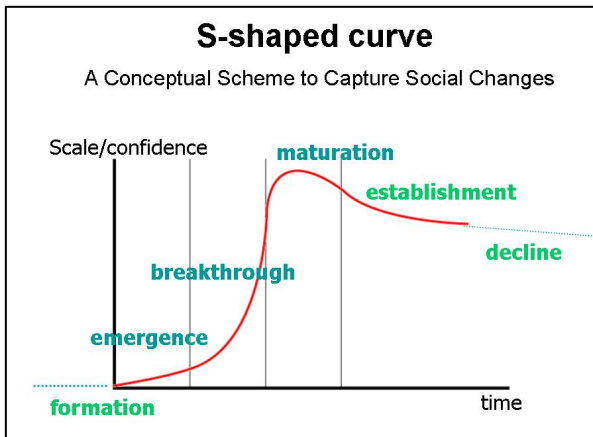


Fig. 1 Conceptual Framework of Capturing General Social Changes

By applying this framework, we can observe three phases of modernization occurred in human society over the past five centuries which led the formation of the Information Society by “informatization”. As is shown in the Fig.2., these phases are:

- 1) Militarization and Prestige Game
- 2) Industrialization and Wealth Game, and
- 3) Informatization & Wisdom Game

The Militarization started around 1550. The Industrialization started around 1750 with the First Industrial Revolution. The Informatization started around 1950 with the First Information Revolution. The Militarization is driven by the Prestige Game, and the Industrialization is driven by the Wealth Game while the Informatization is driven by the Wisdom Game [Kumon 1988] [Kumon and Aizu 1993].

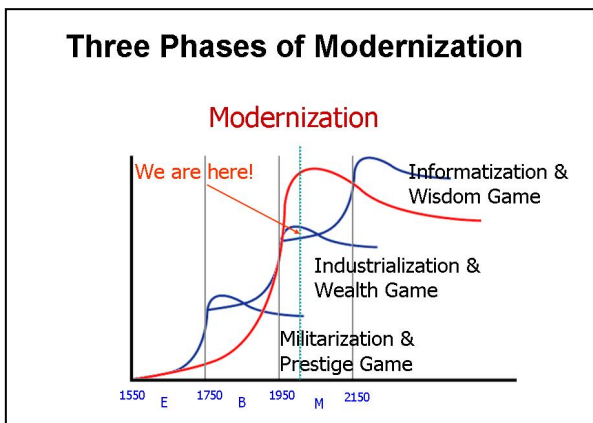


Fig 2. Three Phases of Modernizaion

Looking more deeply, we recognize that the Industrial Revolution itself has occurred in three phases: the first one in the 18 – 19th century, second one in the 19 – 20th century, and the third one in the 20 – 21st century [Kumon 2004].

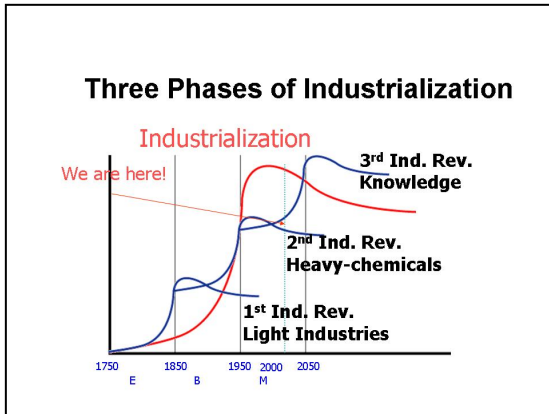


Fig 3. Three Phases of Industrialization

The major elements which shape and represent the three Industrial Revolutions by these phases are shown in Table 1. .

Table1: Major elements and patterns during the three phases of Industrial Revolution

Phase Time Major industry	Emerging period Base material/ Generic Technology	Breakthrough period New Products	Maturing period New Services
First Industrial Revolution 18 -19th Century <i>Light Industries</i>	Iron/ Steam engine	Consumer goods (Fabrics & Cloths)	Transportation Postal Service
Second Industrial Revolution 19 – 20th Century <i>Heavy Chemicals</i>	Steel, Plastics/ Internal Combustion Engine, Electric Motor	Consumer Durables (Car, Electric Appliances)	Mass Services (Entertainment, Education, Medical, Distribution, Financial)
Third Industrial Revolution 20 – 21st Century <i>Information and Knowledge</i>	Information/ Information and Communication Technology	Personal Machine Tools	Personal Care Services and Machines (for Aging Society)

Notes:

- 1) “Consumer Durables” are machines that produce services the consumers or the citizens want and use.
- 2) “Personal Machine Tools” are machines that produce machines that make products the citizens want and use.
- 3) “Personal Care Services Machines” will likely be provided with intelligent high-performance robots to the aging population and other household uses.

In this context, Kumon considered that the industry that produce Personal Machine Tools, universal machines that produce home appliances or any other machines people want and need, first conceived and researched by Neil Garshenfeld, would emerge as the major industry in the third phase of industrialization, the Third Industrial Revolution [Kumon 2004].

The Third Industrial Revolution and the First Information Revolution

We recognize that the Thrid Industrial Revolution and the First Information Revolution are currently running almost in parallel (Fig.3). We believe that understanding this parallel will help grasp the very nature of the impact of the Social Fab movements on the coming stage of our Information Society.

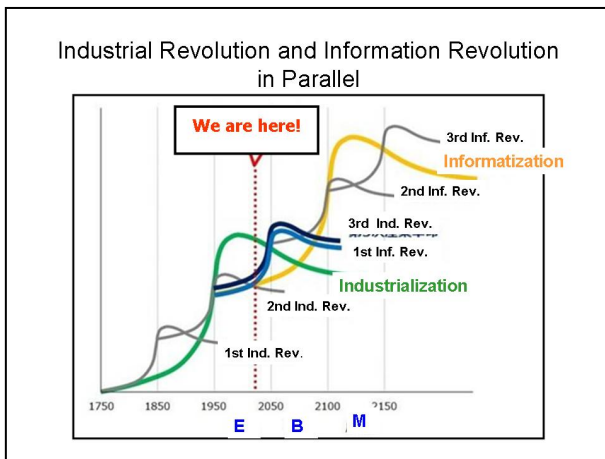


Fig 3. Industrial Revolution and Information Revolution run in parallel

Analyzing the Third Industrial Revolution

First, let us review the discussion around the Thrid Industrial Revolution in detail. Many economists and sociologists agree that the global society is now entering into the Third Industrial Revolution. However, there are several different positions in terms of when it actually started. Some claim it started in the 1960s while others argue 1980s, 1990s or 2000s.

Economist Robert Gordon argues that the Third Industrial Revolution has already started in 1900s, noting the rise of the Digital Computing technology. He points out however, that the Third Industrial Revolution have contributed to the productivity rise only for just 10 years in the late 1990s to the early 2000s amd fihished while the Second Industrial Revolution made significant contribution for nearly 100 years since 1870s,

like the First Industrial Revolution started in 1750.¹ He recognizes such obstacles as aging population, widening gaps between rich and poor, and globalization trend, mostly centered around the United States, that prevent the economy from making sustainable growth in the long run. He seems to be lacking the recognition of the rapid technological innovations following the Moore's Law, constantly generated in various industrial fronts.

Economic and social theorist and political activist Jeremy Rifkin, who has just published a book "*Third Industrial Revolution*", argues that the new Industrial Revolution is initiated by the combination of new communication technology and the new energy resources together [Rifkin 2011]. He sees that the Third Industrial Revolution was generated since the mid-1990s by the combination of the Internet technology and the distributed renewable energy production. At the same time, he observes that the social institutions changed from centralized to distributed, networked shapes. The five major pillars that support this Third Industrial Revolution, according to Rifkin, are:

- 1) Shifting to renewable energy
- 2) Transform all buildings as micro-power plants to collect renewable energy on-site
- 3) Deploy new energy storage technologies such as the use of Hydrogen
- 4) Make the power grids as energy-sharing intergrid similar to the Internet
- 5) Use plug-in electricity or fuel cell for automobiles that allow selling and buying electricity with the shared power grids.

He also emphasizes the importance of making all these five factors work together at the same time. Rifkin argues that "the Third Industrial Revolution and the collaborative era to which it gives rise frees human beings from mechanized labor to engage in *deep play* – which is what sociability is all about. " He continues, "The Third Industrial Revolution and the collaborative era offer humanity the opportunity to liberate itself from the grip of a mechanized life cocooned inside a utilitarian world and breathe in the exhilaration of being free; *We live to play.*"

Though his view on renewable energy seem to be rather optimistic, the notion of "Deep Play" Rifkin emphasizes corresponds to the "conviviality" which the author placed as

¹ Robert J. Gordon, "IS U.S. ECONOMIC GROWTH OVER? FALTERING INNOVATION CONFRONTS THE SIX HEADWINDS"
<http://faculty-web.at.northwestern.edu/economics/gordon/Is%20US%20Economic%20Growth%20Over.pdf>

the core value people will pursue in the Information Age [Kumon 2003]. However, we believe that there should be a clear distinction between the Third Industrial Revolution and the Age of Collaboration it brings about. In our view, the Age of Collaboration will be much more relevant social change with the Information Revolution than the Industrial Revolution.

Chris Anderson provides a simple and straight description of the Third Industrial Revolution as “Makers Movement” in his recent book “Makers: The New Industrial Revolution [Anderson 12]. He argues that the Information Technology revolution in the 1990s did *not* constitute an industrial revolution since it did not involve the material production, however. In other words, he argues that the new industrial revolution has only begun in the early 21st century. We have some reservation on his view, and we note that his argument is rather biased to the business dimension of making things. In fact, he has become a successful entrepreneur and drawing great amount of attention from all over the world with this industrial and business orientation.

We consider that Anderson’s perspective is too limited to the business dimension with the Industrial Revolution orientation and thus hinders the new potential with the introduction of digital, personal and social fabrication movements that Neil Garshenfeld, Hiroya Tanaka and other pioneers are leading and many citizens are actually experiencing [Garshenfeld 12], [Tanaka 12]. As Tanaka claims, the trend is now “from Personal Computers to Personal Fabricators” or “from Web Society to Fab Society” that is going to revolutionize the way people make things, and eventually use things for their own life, beyond the conventional business systems [Tanaka 13]. In other words, Makers movement does not address the new and broader *social* dimension of The First Information Society, developing in addition to or in tandem with the Third Industrial Revolution.

The authors see that the three Industrial Revolutions all came to rise in the middle of each century, which means that the Third Industrial Revolution already began, or emerged, in the 1950s, unlike other theories, which is now taking more visible shape as its breakthrough phase. During the emerging period, new generic technology and base material were rapidly developed as was shown in the Table 1.

There inevitably remains a “Time lag of recognition and deployment”. As the Nobel Prize winner economist Robert Sollow once said, "You can see the computer age

everywhere but in the productivity statistics” [Solow 1987, it may take 30 to 50 years before a large-scale social change became apparent to everyone. We consider that the Third Industrial Revolution already began in the 1950s in the form of “Computer Revolution” or “Digital Revolution”, but it follows the historical pattern of social change that it may take quite some time that the Third Industrial Revolution” will achieve higher productivity gain or high growth rate for the entire economy.

Three Phases of the Third Industrial Revolution

The Third Industrial Revolution could be further broken into three progressive phases, namely, the Emergence (since around 1950), The Breakthrough (since around 1975), and the Maturing phase (since around 2000) shown in Fig. 5.



Fig. 5. First three phases of the Industrial Revolution

The first phase started in the 1950s as the hardware centric phase with Mainframe computers and Time Sharing System as the main driver of digital computing technology and services.

Since the late 70s, the “downsizing” of the small computers became the major trend, allowing individuals to own and use digital computers, that gave birth to the Personal Computers. It also gave priorities to the software, instead of the hardware. The software became the independent products and gave birth to the software industry. It drove the second phase of the Industrial Revolution. The PCs are also connected to the servers via LAN, marking the server-client paradigm of computing, or networking.

Since late 1990s to early 2000s, the trends towards networking became central. The rise

of the Internet and its services drove the age of Cloud computing, with Tablet computers and smart phones connected to the Net. It also gave priority to “data”, not hardware or software, making it the “King” of the digital computing world in the globally networked environment.

Different Characteristics of the Third Industrial Revolution and First Information Revolution compared

We see the Third Industrial Revolution and the First Information Revolution run in parallel though they have different characteristics. General trends of the times and the major elements that characterize social changes in the Third Industrial Revolution and the First Information Revolution which have started in late 20th century are shown in Table 2.

		Third Industrial Revolution Creating New Industry	First Information Revolution Creating New Lifestyles
		Genera Trends and Major elements	
Phase and main characters		Digitization	Socialization
1950~ Emerging Phase	C&C Network Society, Information centric	Digital Computing	Social Communication
	1950~	Main Frame & Time Sharing Hardware centric	New social awareness & Counter Culture
	1975~	Servers/ Personal Computers Software centric	Networking Movements
	2000~	Mobile & Tablet Computers Cloud Computing Network & Data centric	Social Media and Networked Politics
2000~ Breakthrough Phase:	Fab Socialization Things and Creatures centric	Digital Manufacturing	Social Fabrication
	2010~	Makers Movement	FabLab Movement
	2025~	Fab Industry	Fab Community
2050~ Maturing Phase	Symbiotic Society Human centric	Digital Servicing	Social Institutions
	2050~	Robotic Industry	New Safety Network

Table 2: Characteristics of Third Industrial Revolution and First Information Revolution

Here, we see a clear distinction between “Makers Movement” argued by Anderson et a

and “Social Fab” movement proposed by Garshenfeld, Tanaka et al. The former tends to be “industry” oriented while the latter tends to be a society or community oriented.

The growth rate of these movements is significant. There were some 250 FabLabs existed in February 2013. It was 145 in November 2012, showing a 20 % increase per month during the three month period. If this trend continues, it will be 16,000 in 2015 and 1 million in 2017. It may not be realistic to expect 1 million FabLabs in less than five years from now, but the number of low-end 3D printers and other digital fabrication machines will highly likely be surpassing these figures without much obstacle given current degree of popularity worldwide. It is the “Social” dimension that is the key driver of the phenomenal growth to come.

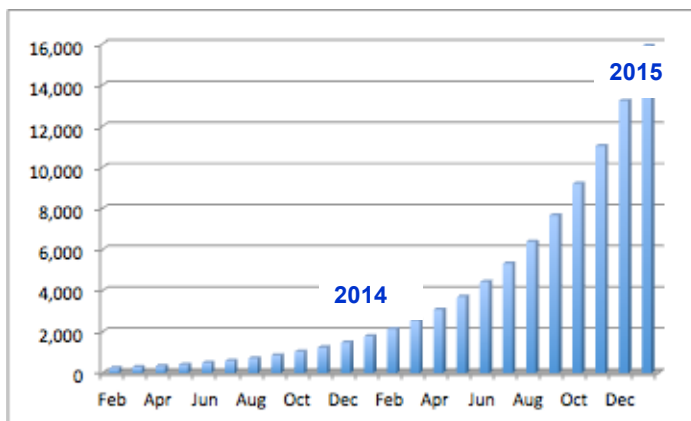


Fig. 6. The projected growth of the FabLabs worldwide

3. Maturing the Social Communication: deployment of the Social Media

To understand the impact of “Social” dimension, let us go back the history of social communication to the 1980s.

It was in the mid 1980s to the early 1990s when the first phase of Social Communication came of age. The PC based communication services such as The Source and CompuServe in the United States became popular following the Bulletin Board Service (BBS) first invented by Ward Christensen. Grass-root networking service called The WELL (Whole Earth eLEctronic Link) started in California became an avid online community around 1984 – 1985. The early days of these virtual communities and their historical significance are well chronicled by Howard Rheingold in his book *“The Virtual*

Community". In its Introduction, Rheingold wrote:

"The virtual village of a few hundred people I stumbled upon in 1985 grew to eight thousand by 1993. It became clear to me during the first months of that history that I was participating in the self-design of a new kind of culture. I watched the community's social contracts stretch and change as the people who discovered and started building the WELL in its first year or two were joined by so many others. Norms were established, challenged, changed, reestablished, rechallenged, in a kind of speeded-up social evolution." [Rheingold 1993]

Linda Harasim observed these new activities in "*Global Networks*" as Social Space, as she noted:

"The fusion of computers and telecommunications over the past twenty years has created a worldwide web of computer networks; these networks, initially established for transferring data, have been adopted by people who want to communicate with other people. Human communication has become the major use of computer networks and transformed them into a social space where people connect with one another. Computer networks are not merely tools whereby we network; they have come to be experienced as places where we network: a network." [Harasim 1993]

In these early days, people formed "online community" with other members of the same network service such as the WELL or CompuServe, thus their mind was still limited within the boundaries of the specific services they subscribed to. It could be described as "group mind", consist of a few thousand to some tens of thousand members of the particular community [Kumon 1988].

The Internet radically changed the situation in the early 1990s. The widespread use of the world-wide web triggered by the graphical interface browsers such as Mosaic and Netscape captured the large amount of attention of the people and eventually created the "dot-com industry" which ended up with the burst of many startups in the Silicon Valley around 2000.

However, the Internet-based services or movements did not die there. A new emerging trend under the banner of "*Social*" has become the next central engine for evolution around the Internet. Represented by such terms as "Social Network" or "Social Network Services", twitter, Facebook, YouTube and a many other online social services became highly popular from the mid 2000s into the 2010s.

To illustrate this new trend, Mark Benioff, CEO of the Salesforce claimed the rise of "Social Revolution" at the Dreamforce conference in August 2011. He declared:

“We were born cloud, but today we're reborn social.”

“Let me tell you what I love about my job. It's the constant, never-ending change. That's what's so exciting, what's constantly changing about our industry. It's from the mainframes, from IBM and Thomas Watson, and from the era of Bill Gates to control our industry. But we moved past that, thank God, and we moved into the mobile era led by none other than the great Steve Jobs. And now we're being led into an exciting new era, and this new era that is happening today is this social revolution, and which is why we want to bring you a social enterprise.”²

As Benioff rightly points out, the main actor of the social revolution is *not* the IT vendors such as Microsoft or IBM, but the social platform services such as twitter or Facebook. Those who understands the new rules of the game – the users or the consumers lead and provide the content of the services, not the other way around, – became the winner.

Connecting material objects in addition to cognitive objects

However, the “socialization” will not stop there. So far, these Social Networking Services have connected people with people, or rather, the minds of the people, together. More specifically, the object people exchanged over these services are those recognized inside the human brains: words, sound, and graphical images in the form of digital data. They are cognitive objects.

The digital fabrication has changed this situation. People are now able to share digital data that produce things, or physical objects, in addition to the cognitive objects. By making it digital, we can exchange them over the Internet easily and instantly with little cost. Machines that process these digital data and transform them into physical shape, 3D printers, Laser cutters, Milling machines, or any other digital machine tools, are connected over the Internet with various applications and services.

The application of digital processing power to the manufacturing is not at all new. With the introduction of CAD/CAM applications and Numerically Controlled (NC) machines, digital computing has already become the essential part of the state-of-the art production techniques in many industrial plants today.

What is new, however, is the fact that the users of these new digital manufacturing tools becoming the engine of the changes. With the rapid reduction of both size and price,

² <http://readwrite.com/2011/08/31/live-from-dreamforce-11---sale#awesm=~of0ldaBsKYhWVo>

the new digital fabrication machines such as 3D printers are becoming affordable to ordinary citizens. Coupled with the use of the Internet, the very process of using these machines and its outcomes, design and product data, are now created and then largely shared and modified among the users in manners similar to the open source movements in the software field. We observe that the people engaged in Social Fabrication movements are forming communities, again close to the Open Source Software community or Internet Community in their early days.

Digital industrialization which started in the shape of digital computing in the 1950s is now entering into its Breakthrough period driven by the new wave made possible by combining technologies of “bits” and that of “atoms”. Computers who used to process information is now becoming capable of processing or producing physical objects.

4. The rise of Social and Universal Fabricator

What is significant in terms of social change currently undergoing is their impact on the real world, the Information Society we live in. Before, the people are connecting their mind, with cognitive objects, but now they are connecting the material goods they produce and share as digital data. What will be then made possible by this shift?

The digital computers in their first 50 years played a significant role of being a simulator. By manipulating digital data, signals, words, graphical images and sounds, or variables in the logical sphere, computers became the simulating machines. By handling both time-factor and space-factor separately, computers allowed humans to simulate the world in the logical sphere. Thus we could simulate “almost anything” so long as they are defined within our logical system space. In short, computers became virtual simulating machines or universal simulators.

The evolution of computing capabilities did not stop there, however. When combined with 3D Scanners and Machine Tools, computers become capable of making “almost anything” so long as they follow the Laws of Physics. In short, computers are now being evolved into “virtualizer” or “universal fabrication machines.” Kumon first noted this tremendous potential of social change brought by “personal fab” and its extensions including “universal fabrication” in 2003 [Kumon 2004].

This evolution is conceived as the “breakthrough” within the digitalization process in the Third Industrial Revolution framework, but it is also a “breakthrough” contributing to the socialization process of the First Information Revolution at the same time. In this regard, the social dimension of “universal fabrication” will become the main source of the next major change for our society as a whole.

What seems to be still in its infancy, the social fab movements of today, may spread all over the globe possibly within next 15 to 30 years. It took almost the same time for the Internet to reach the current state. This new social fab movement will allow people to interact more creatively with physical objects, be it art, appliances, gadgets or daily commodities, and will therefore provide greater sense of positive feel – “deep play” to borrow Rifkin’s words – or “conviviality” as the author (Kumon) has been placing as the central value of the *Netziens* in the coming Information Society [Kumon 2004].

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Finally, we are ready to explore this brave new world ourselves, together with the research activities of the Institute for HyperNetworks, based in Oita, for opening up a new Fab Lab in Oita, as well as with the Institute for InfoSocionomics, based in Tokyo, for further theoretical exercises.